TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE

(Founded in 1868)

VOLUME 41

F. C. GATES, *Editor*
W. J BAUMGARTNER, *Managing Editor*

SEVENTIETH ANNUAL MEETING, MARCH 31, APRIL 1 AND 2, 1938

KANSAS STATE TEACHERS COLLEGE
PITTSBURG, KANSAS

Correspondence should be addressed as follows:

Manuscripts: F. C. GATES, Editor, Manhattan, Kan.

Exchanges: Library of
1. UNIVERSITY OF KANSAS, Lawrence, Kan., or
2. KANSAS STATE COLLEGE, Manhattan, Kan., or
3. FORT HAYS KANSAS STATE COLLEGE, Hays, Kan.

Other Business: ROGER C. SMITH, *Secretary*,
Manhattan, Kansas, U. S. A.

PRINTED BY KANSAS STATE PRINTING PLANT
W. C. AUSTIN, STATE PRINTER
TOPEKA 19[illegible]
17-4992

TABLE OF CONTENTS

OFFICIAL

PAPERS AND ABSTRACTS

CONSTITUTION AND BYLAWS

CONSTITUTION *

SECTION 1. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in various departments of science.

SEC. 3. The membership of this Academy shall consist of three classes: annual, life and honorary.

(1) Annual members may be elected at any time by the committee on membership, which shall consist of the secretary and other members appointed, annually, by the president. Annual members shall pay annual dues of one dollar, but the secretary and treasurer shall be exempt from the payment of dues during the years of their service.

(2) Any person who shall have paid thirty dollars in annual dues, or equivalent due to legal exemption, or in one sum, or in any combination, may be elected to life membership, free of assessment, by a two-thirds vote of the members present at an annual meeting.

(3) Honorary members may be elected because of special prominence in science upon written recommendation of two members of the Academy, by a two-thirds vote of the members present. Honorary members pay no dues.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, the president-elect, a vice-president, a secretary and a treasurer, who shall perform the duties usually pertaining to their respective offices. The president, the secretary and the treasurer shall constitute the executive committee. The secretary shall be in charge of all the books, collections and material property belonging to the Academy.

SEC. 5. Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the executive committee shall designate. Other meetings may be called at the discretion of the executive committee.

SEC. 6. This constitution may be altered or amended at any annual meeting by a vote of three fourths of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

SEC. 7. This Academy shall have an executive council, consisting of the president, the president-elect, the secretary, the treasurer, the retiring presidents, the editor, the managing editor, and three other members to be nominated by the nominating committee and elected as the other officers. This council shall have general oversight of the Academy not otherwise given by this Constitution to officers or committees.

SEC. 8. This Academy shall have an editorial board consisting of an editor, a managing editor, and four associate editors. These members shall be elected in the same manner as other officers, but for a period of three years. Two

*As modified by amendments.

members of the board shall be elected every year, except that in 1935 the editor and one associate shall be elected for three years, the managing editor and one associate for two years and two associates for one year each.

The editor, with the aid of the associate editors, shall have general supervision of all editorial work submitted for publication in the Transactions, and shall be responsible for the selecting, editing, revision and rejection of papers submitted for publication. The managing editor shall be responsible for the making of the plates and the printing and general distribution of the Transactions.

BYLAWS

I. At the beginning of each annual session there shall be held a brief business meeting for announcements and appointment of committees. For the main business meeting, held later in the session, the following order is suggested:

1. Reports of officers.
2. Reports of standing committees.
3. Unfinished business.
4. New business.
5. Reports of special committees.
6. Election of officers.
7. Election of life and honorary members.

II. The president shall deliver a public address on the evening of one of the days of the meeting, at the expiration of his term of office.

III. No meeting shall be held without a notice of the same having been published in the papers of the state at least thirty days previous.

IV. No bill against the Academy shall be paid by the treasurer without an order signed by the president and secretary.

V. Names of members more than one year in arrears in dues shall be dropped from the membership list.

VI. The secretary shall have charge of the distribution, sale and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the executive committee.

VII. Ten percent of the active membership shall constitute a quorum for the transaction of business. Section meetings may not be scheduled or held at the time a business meeting is called by the president at a general session or announced on the program.

VIII. The time allotted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

X. Section programs may be arranged by the secretary with the advice of the section chairmen. The subdivision or combination of existing sections shall be dependent upon the number of papers to be presented. Such changes shall be made by the secretary in accordance with the policies of the Academy and after receiving the advice of the chairmen of the sections concerned.

XI. Section chairmen for the ensuing year shall be elected annually at the close of the section meetings.

XII. Section programs shall be limited to Friday afternoon of the annual session, but may be continued Saturday afternoon if desired by the section chairman. Exemptions to this must receive the approval of the executive committee.

XIII. In selecting papers for publication in the Transactions of the Kansas Academy of Science, the editor or editorial board shall refuse papers by non-members and members who are in arrears.

MEMBERSHIP OF THE ACADEMY

April 20, 1938

ABBREVIATIONS: The following abbreviations for institutions have been used:

U. of K.: University of Kansas.
K. S. C.: Kansas State College of Agriculture and Applied Science.
K. S. T. C.: Kansas State Teachers College.
F. H. K. S. C.: Fort Hays Kansas State College.
H. S.: High School.
Jr. H. S.: Junior High School.
Jr. Col.: Junior College.

Other abbreviations follow those used in the Summarized Proceedings of the American Association for the Advancement of Science.

The year given indicates the time of election to membership.

HONORARY MEMBERS

Barber, Marshall A., Ph. D., 1904, Internat. Health Div., Rockefeller Found., 49 W. Forty-ninth street, New York, N. Y.

Cockerell, T. D. A., D. Sc., 1908, prof. zoölogy (emeritus), Univ. Colorado, Boulder, Colo.

Grimsley, G. P., Ph. D., 1896, geological eng., B. & O. R. R., 4405 Underwood Road (Guilford), Baltimore, Md.

McClung, C. E., Ph. D., 1903, dir. zoölogy lab., Univ. Pennsylvania, Philadelphia, Pa.

McCollum, E. V., Ph. D., Sc. D., 1902, prof. biochemistry, Johns Hopkins Univ., Baltimore, Md.

Nichols, Edward L., Ph. D., Sc. D., 1885 (honorary member 1897), prof. physics (emeritus), Cornell Univ., Ithaca, N. Y.

Riggs, Elmer S., M. A., 1896, assoc. curator paleontology, Field Mus. Nat. Hist., Chicago, Ill.

Wagner, George, M. A., 1897 (honorary member 1904), prof. zoölogy, 73 Biology Bldg., Univ. Wisconsin, Madison, Wis.

LIFE MEMBERS

Agrelius, Frank U. G., M. A., 1905, assoc. prof. biol., K. S. T. C., Emporia, Kan.

Allen, Herman Camp, Ph. D., 1904, prof. chemistry, U. of K., Lawrence, Kan.

Bartow, Edward, Ph. D., Sc. D., 1897, prof. and head Dept. Chem. and Chem. Eng., State Univ. Iowa, Iowa City, Iowa.

Baumgartner, William J., Ph. D., 1904, prof. zoölogy, U. of K., Lawrence, Kan.

Beede, Joshua W., Ph. D., 1894, prof. geology and paleontology, Indiana Univ., Bloomington, Ind.

Berry, Sister M. Sebastion, A. B., 1911, Supt. Schools, St. Paul, Kan.

Bushnell, Leland D., Ph. D., 1908, prof. and head Bacteriology Dept., K. S. C., Manhattan, Kan.

Bushong, F. W., Sc. D., 1896, 2636 Fifth street, Port Arthur, Tex.

Cady, Hamilton P., Ph. D., 1904, prof. chemistry, U. of K., Lawrence, Kan.

Cook, W. A., M. S., 1907, real estate business, 1414 Highland street, Salina, Kan.

Copley, Rev. John T., 1903, Olathe, Kan. Died May 4, 1938.

Dains, Frank Burnett, Ph. D., 1902, prof. chemistry, U. of K., Lawrence, Kan.

Dean, Geo. A., M. S., 1903; 1912, head Dept. of Entomology, K. S. C., Manhattan, Kan.

Deere, Emil O., M. S., 1905, dean and prof. biology, Bethany Col., Lindsborg, Kan.

Dellinger, Orris P., Ph. D., 1909, prof. biology, K. S. T. C., Pittsburg, Kan.

Dunlevy, R. B., M. A., 1896, Southwestern Col., Winfield, Kan.

Ebv, J. Whit, B. S., 1903, banker, Howard, Kan.

Failyer, George H., M. S., 1878, retired, R. R. 4, Manhattan, Kan.

Faragher, Warren F., Ph. D., 1927, dir. of Research Catalytic Dev. Co., 1608 Walnut street, Philadelphia, Pa.

Garrett, A. O., M. A., 1901, head Dept. Biology, East High School, Salt Lake City, Utah.
Graham, I. D., M. S., 1879, State Board of Agric., Topeka, Kan.
Harman, Mary T., Ph. D., 1912, prof. zoölogy, K. S. C., Manhattan, Kan.
Harnly, Henry J., Ph. D., 1898, prof. biology, McPherson Col., McPherson, Kan.
Harshbarger, William A., Sc. D., 1903, prof. mathematics, Washburn Col., Topeka, Kan.
Havenhill, L. D., Ph. C., 1904, dean School of Pharmacy, U. of K., Lawrence, Kan.
King, H. H., Ph. D., 1909, prof. and head Dept. Chemistry, K. S. C., Manhattan, Kan.
Meeker, Grace R., 1899, 709 S. Mulberry, Ottawa, Kan.
Menninger, C. F., M. D., 1903, 3617 W. Sixth avenue, Topeka, Kan.
Nabours, Robert K., Ph. D., 1910, prof. and head Zoölogy Dept., K. S. C., Manhattan, Kan.
Nissen, A. M., A. B., 1888, farmer, Wetmore, Kan.
Peace, Larry M., 1904, 512 W. Ninth street, Lawrence, Kan.
Reagen, Mrs. Otilla, 1937, Startup Apts., Provo, Utah.
Robertson, W. R. B., Ph. D., 1905, Anat. Dept., Univ. Iowa, Iowa City, Iowa.
Schaffner, John H., M. S., 1903, research and prof. botany, Ohio State Univ., Columbus, Ohio.
Scheffer, Theodore, M. A., 1903, assoc. biologist, U. S. Biological Survey, Puyallup, Wash.
Shirk, J. A. G., 1904, prof. mathematics, K. S. T. C., Pittsburg, Kan.
Smith, Alva J., 1892, consulting eng., 810 Boylston street, Pasadena, Cal.
Smyth, E. Graywood, 1901, entomologist, Cia. Agricola Carabayllo, Hacienda Cartavio, Trujillo, Peru.
Smyth, Lumina C. R., Ph. D., 1902, 16802 Dartmouth, Cleveland, Ohio.
Sternberg, Charles H., M. A., 1896, 4046 Arizona street, San Diego, Cal.
Stevens, Wm. C., 1890, 1121 Louisiana street, Lawrence, Kan.
Welin, John Eric, D. Sc., 1889, prof. chemistry, Bethany Col., Lindsborg, Kan.
Wells, J. R., Ph. D., 1934, prof. biology, K. S. T. C., Pittsburg, Kan.
White, E. A., M. A., 1904, prof. chemistry, U. of K., Lawrence, Kan.
Willard, Julius T., D. Sc., 1883, college historian, K. S. C., Manhattan, Kan.
Wilson, William B., Sc. D., 1903, head Biology Dept., Ottawa Univ., Ottawa, Kan.
Wooster, Lyman C., Ph. D., 1017 Union street, Emporia, Kan.

ANNUAL MEMBERS

Members who paid their 1938 dues before May 1, 1938, are indicated by an asterisk (*). The year given is that of election to membership. If two years are given, the second signifies reëlection.

*Abernathy, George Elmer, Ph. D., 1938, geologist, Kansas State Geological Survey, Pittsburg, Kan.
*Ackert, James E., Ph. D., 1917, prof. zoölogy and parasitology, dean Grad. Div., K. S. C., Manhattan, Kan.
*Aicher, L. C., B. A., 1930, supt. Fort Hays Branch, K. S. A. Expt. Sta., Hays, Kan.
*Albertson, F. W., Ph. D., 1935, prof. botany, F. H. K. S. C., Hays, Kan.
*Albertson, Maurice, student, 1938, F. H. K. S. C., Hays, Kan.
*Albright, Penrose S., Ph. D., 1926, asst. prof. physics and chem., Southwestern Col., Winfield, Kan.
*Aldous, Alfred E., Ph. D., 1937, prof. pasture improvement, Dept. Agronomy, K. S. C., Manhattan, Kan. Died May 4, 1938.
*Alexander, Stanley, B. S., 1938, instr. U. of K., Topeka, Kan.
*Allegre, Charles, B. S., 1935, 411 Ellinwood, Osage City, Kan.
*Allen, M. W., M. S., 1938, Dept. Biological Sc., Fort Scott Jr. Col., Fort Scott, Kan.
*Allen, Paul B., M. S., 1938, principal, Ottawa Public Schools, Ottawa, Kan.
Allsbury, Carl, 1937, student, K. S. T. C., Emporia, Kan.
*Alm, O. W., Ph. D., 1931, assoc. prof. psychology, K. S. C., Manhattan, Kan.
*Alsop, Annette, B. S., 1937, K. S. C., Manhattan, Kan.
Alsop, M. L., M. S., 1932, Wamego, Kan.
*Ameel, Donald J., Sc. D., 1937, inst. zoölogy, K. S. C., Manhattan, Kan.
*Andrews, Theodore F., 1938, student, K. S. T. C., Emporia, Kan.
*Angell, Wenonah E., 1936, Medicine Lodge, Kan.
*Arkansas General Library, 1938, Univ. of Arkansas, Fayetteville, Ark.
Atkeson, F. W., M. S., 1937, head Dairy Dept., K. S. C., Manhattan, Kan.
Atkinson, Esther, M. S., 1937, instr. home economics, McPherson College, McPherson, Kan.

Aubel, C. E., Ph. D., 1933, assoc. prof. animal husbandry, K. S. C., Manhattan, Kan.
Ayers, John C., A. B., 1936. Duke Univ., Durham, N. C.
*Babcock, Rodney W., Ph. D., 1931, dean Div. Gen. Sc., K. S. C., Manhattan, Kan.
*Baden, Martin W., Sc. D., 1921, Box 520, Winfield, Kan.
*Bailey, Lorene, M. S., 1932, 3005 Stevens, Parsons Kan.
Baldwin, Alfred L., M. A., 1937, Dept. Psychology, U. of K., Lawrence, Kan.
*Banion, Elmer L., 1938, 508 W. Sycamore St., Independence, Kan.
Bardo, Carol, A. B. 1933, lab. technician, Suite 14, Arcade Bldg., Arkansas City, Kan.
*Barnett, R. J., M. S., 1922, prof. horticulture, K. S. C., Manhattan, Kan.
*Barnhart, Carl, B. S., 1932, instr. H. S. East, Wichita, Kan.
*Barton, Arthur W., Ph. D., 1928, head Botany Dept. F. H. K. S. C., Hays, Kan.
*Bates, James C., Ph. D., 1933, asst. instr. botany, K. S. C., Manhattan, Kan.
*Bawden, William T., Ph. D., 1938, head Dept. Indus. & Vocational Education, K. S. T. C., Pittsburg, Kan.
*Bayles, Ernest E., Ph. D., 1936, assoc. prof. education, U. of K., Lawrence, Kan.
*Beach, Edith, M. A., 1931, 812 Illinois street, Lawrence, Kan.
*Beck, Gladys, M. S., 1937 Wyandotte High School, K. C. Kan.
*Bennett, Dewey, M. A., 1928, instr. biology and chem., Jr. Col., Garden City, Kan.
*Berger, Carl W., B. S., 1938, petroleum chemist, McPherson, Kan.
*Bergstresser, Karl S., Ph. D., 1937, head Chem. Dept. Ottawa University, Ottawa, Kan.
Bernhart, Arthur, Ph. D., 1937, instr. math. and physics, Ottawa Universtiy, Ottawa, Kan.
*Blackman, Leslie E., Ph. D., 1935, head Dept. Chem., K. S. T. C., Emporia, Kan.
*Blanchard, Lloyd M., 1938, Engr. Geology, W. P. A. of Kans., Topeka, Kan.
Bogart, Ralph, B. S., 1936, R. D. No. 2, Ithaca, N. Y.
*Boughton, L. L., M. S., 1929, asst. prof. pharmacy, U. of K., Lawrence, Kan.
*Bowman, J. L., M. S., 1928, prof. physics, McPherson College, McPherson, Kan.
*Brady, Miss Laurane, B. S., 1938, Conception, Mo.
*Branch, Hazel E., Ph. D., 1924, prof. zoölogy, Univ. of Wichita, Wichita, Kan.
*Branson, Lester R., B. S., 1938, student, Coats, Kan.
*Brazil, James, A. B., 1938, Geologist, Kansas Board of Health, Sanitation Dept., Hays, Kan.
*Breithaupt, Gail M., M. S., 1938, 217 N. Popular, Edgerton, Kan.
*Brennan, L. A., M. S., 1933, principal, High School, Andale, Kan.
*Breukelman, John, Ph. D., 1930, prof. biology, K. S. T. C., Emporia, Kan.
*Brewster, Ray Q., Ph. D., 1919, prof. chemistry, U. of K., Lawrence, Kan.
Brickey, Harold, 1937, student of Chem., K. S. T. C., Emporia, Kan.
*Bridwell, Arthur, A. B., 1937, collector geol. spec., K. U. Museum, Baldwin City, Kan.
*Brigden, Robert L., Ph. D., 1931, Child Research Lab., Wichita, Kan.
Briscoe, Florene, 1935, 404 Snow street, U. of K., Lawrence, Kan.
*Brooks, C. H., M. S., 1929, 1938, Extension division, F. H. K. S. C., Hays, Kan.
*Brooks, Travis E., 1937, student, K. S. C., Manhattan, Kan.
*Brown, Harold P., Ph. D., 1934, prof. chemistry, Univ. Kansas City, Kansas City, Mo.
*Brownlee, J. A., A. M., 1937, 340 N. Ash street, Wichita, Kan.
*Brubaker, H. W., Ph. D., 1929, prof. chem., K. S. C., Manhattan, Kan.
*Bryson, Harry R., M. S., 1933, asst. prof. entomology, K. S. C., Manhattan, Kan.
*Bugbee, Robert E., Ph. D., 1937, College of Emporia, Emporia, Kan.
*Burford, Wesley R., 1937, student, F. H. K. S. C., Hays, Kan.
*Burke, Miss Cecelia, B. S., 1938, Mount St., Scholastica College, Atchison, Kan.
*Burnett, R. Will, B. A., 1938, head of Sc. Dept., Concordia High School, Concordia, Kan.
*Burt, Charles E., Ph. D., 1932, prof. biology, Southwestern College, Winfield, Kan.
*Burt, Lucile, A. M., 1937, Dept. botany, K. S. C., Manhattan, Kan.
Byrne, Frank., S. B., 1937, instr. in geology, K. S. C., Manhattan, Kan.
*Calhoun, Arthur W., Ph. D., 1937, dean and prof. psychology and philosophy, Sterling College, Sterling, Kan.
*Calkins, Edward Jesse, M. S., 1938, asst. prof. of education, K. S. T. C., Emporia, Kan.
*Call, L. E., M. S., 1922, dean Division of Agri., dir. Agr. Exp. Sta., K. S. C., Manhattan, Kan.
*Campbell, Marion I., M. S., 1929, Topeka State Hospital, Topeka, Kan.
*Cardwell, A. B., Ph. D., 1937, prof. and head Dept. Physics, K. S. C., Manhattan, Kan.
Carpenter, Albert C., 1929, President Lesh Oil Co., Ottawa, Kan.
*Carroll, Jane, B. S., 1938, prof. elementary education, K. S. T. C., Pittsburg, Kan.
*Carter, Vernon L., B. S., 1937, instr. science, Oxford, Kan.

*Case, Arthur A., B. S., 1938, grad. res. asst. in zoölogy, K. S. C., Manhattan, Kan.
Cauthen, Geo. E., M. S., 1937, instr. zoölogy, K. S. C., Manhattan, Kan.
*Chapin, Ernest K., M. S., 1934, assoc. prof. physics, K. S. C., Manhattan, Kan.
*Chapman, O. W., Ph. D., 1938, prof. chem., K. S. T. C., Pittsburg, Kan.
*Choguill, Harold S., A. M., 1934, 210 N. Tenth St., Independence, Kan.
Clark, J. Tate, A. B., 1937, Phillips Petroleum Co., 722 Nixon Bldg., Corpus Christi, Tex.
*Coco, Russell M., M. S., 1932, Dept. Zoölogy, Univ. of Louisiana, Baton Rouge, La.
*Cohoe, Edith, M. S., 1938, 15370 Farrer, Detroit, Mich.
Coleman, Hubert P., A. B., 1937, Elkhart, Kan.
*Colyer, E. E., A. M., 1937, head Dept. Math., F. H. K. S. C., Hays, Kan.
*Connecticut State College Library, 1937, Storrs, Conn.
*Corey, William Lee, D. C., M. D., 1937, 3706 E. Seventh street, Kansas City, Mo.
*Coventry, Margaret, M. S., 1938, instr. chem., K. S. T. C., Pittsburg, Kan.
Cotton, Richard T., Ph. D., 1935, senior entomologist, U. S. D. A., Manhattan, Kan.
*Cowan, Edwina, Ph. D., 1929, dir. Wichita Child Res. Lab., Wichita, Kan.
*Cram, S. Winston, Ph. D., 1937, prof. physics, K. S. T. C., Emporia, Kan.
*Crow, H. Ernest, Ph. D., 1926, prof. biology, Friends Univ., Wichita, Kan.
Cunningham, Arleigh, B. S., 1937, Miller High School, Miller, Kan.
*Cunningham, Chester B., M. A., 1938, instr. physics, Lawrence, Kan.
*Curtiss, Charles, A. B., 1938, grad. student, Dept. Entomology, K. S. C., Manhattan, Kan.
*Dalton, Standlee, M. S., 1937, Dept. Zoölogy, F. H. K. S. C., Hays, Kan.
Dashen, Ludwig, M. A., 1937, address unknown.
*Davidson, Arthur W., Ph. D., 1927, assoc. prof. chem., U. of K., Lawrence, Kan.
*Davis, Philip B., 1938, student, 1503 E. Euclid, McPherson, Kan.
*Dennis, Parley W., M. S., 1936, 212 E. Cottonwood, Independence, Kan.
*Dewitt, Jack, M. S., 1938, instr. Fort Scott Jr. Col., Fort Scott, Kan.
*Dickinson, F. H., M. S., 1938, asst. prof. ind. and voc. edu., K. S. T. C., Pittsburg, Kan.
*Dickman, Sister Regina Marie, M. S., 1937, instr. foods, Marymount Col., Salina, Kan.
*Dill, Florence E., A. B., 1938, grad. student, 1301 Ohio street, Lawrence, Kan.
*Dillon, Franklin, M. S., 1938, grad. asst. ent., K. S. C., Manhattan, Kan.
*Dobrovolny, Charles G., M. S., 1930, Dept. Zoölogy, Univ. of Mich., Ann Arbor, Mich.
*Doell, J. H., Ph. D., 1926, prof. biology, Bethel Col., Kan.
Doell, Norma, A. B., 1937, address unknown.
Doubt, Sarah L., Ph. D., 1935, prof. botany, Washburn Col., Topeka, Kan.
Douglass, J. R., M. S., 1928, assoc. entomologist, box 1100, U. S. Bur. Ent. and P. Q., Twin Falls, Idaho.
*Drake, Ralph L., M. D., 1938, psychiatrist, Wichita Child Res. Lab., Wichita, Kan.
*Dresher, C. H., B. S., 1930, 320 N. Maxwell, McPherson, Kan.
*Driver, D. D., A. M., 1938, instr. in math. and physical science, Hesston, Kan.
Duley, F. L., Ph. D., 1929, Soil Conservation Res., Lincoln, Neb.
*Dunbar, Irene W., B. S., 1938, 407 S. Elm street., Pittsburg, Kan.
*Durell, William Donald, B. S., 1938, instr. botany, 643 Tennessee street, U. of K., Lawrence, Kan.
*Dutro, Ruth, A. B., 1938, 499 S. Market street, Hagerstown, Ind.
*Edberg, Harold, B. S., 1938, student, Kackley, Kan.
*Edgar, Allen, 1938, student, Dept. Zoölogy, K. S. C., Manhattan, Kan.
Elias, M. K., D. Sc., 1937, Production Dept., Socony Vaccuum Oil Co., Broadway, New York, N. Y.
*Ellis, Ralph, 1935, 2420 Ridge Road, Berkeley, Cal.
*Elwell, Leonard H., 1936, grad. res. asst. zoöl., K. S. C., Manhattan, Kan.
*Embrich, Major John R., M. S., 1938, Fort Riley, Kan.
*Emery, Albert T., N. D., 1938, 222 E. Eleventh street, Kansas City, Mo.
*Emery, W. T., M. A., 1928, asst. entomologist, U. S. D. A., Manhattan, Kan.
*Enberg, L. A., 1935, The Carey Salt Co., Hutchinson, Kan.
*Enders, John W., 1938, student, Lyons, Kan.
Everhardy, Louise H., M. A., 1931, assoc. prof. art., K. S. C., Manhattan, Kan.
*Evers, Robert A., B. S., 1931, 1303½ State street, Quincy, Ill.
*Farrell, F. D., D. Agr., 1924, president, K. S. C., Manhattan, Kan.
*Fellows, Hurley, Ph. D., 1938, assoc. pathologist U. S. D. A., Manhattan, Kan.
*Ficke, C. H., M. S., 1938, junior pathologist, U. S. D. A., Manhattan, Kan.
Filinger, George A., Ph. D., 1932, asst. prof. pomology, K. S. C., Manhattan, Kan.

*Finerty, Jack, A. B., 1938, grad. asst., Zoölogy Dept., K. S. C., Manhattan, Kan.
*Fletcher, Hazel M., Ph. D., 1937, res. asst., Dept. Home Ec., K. S. C., Manhattan, Kan.
*Flora, S. D., 1934, meteorologist, U. S. Weather Bureau, Topeka, Kan.
Floyd, Willis W., Ph. D., 1932, Sam Houston State Teachers College, Huntsville, Tex.
Ford, Helen, Ph. D., 1928, head Dept. Child Welfare and Euthenics, K. S. C., Manhattan, Kan.
*Frain, Kenneth, B. S., 1938, student, Bethany College, Lindsborg, Kan.
*Francis, L. D., Ph. D., 1938, assoc. prof. home ec., K. S. T. C., Pittsburg, Kan.
*Fraser, S. V., Rev., 1931, Aurora, Kan.
Frazier, J. C., M. A., 1937, asst. plant path., K. S. C., Manhattan, Kan.
Freeman, Alva E., B. S., 1936, 468 S. Darlington, Tulsa, Okla.
Friesen, Abraham P., 1936, head Dept. Physics, Bethel College, Kan.
*Fritz, Roy F., B. S., 1938, grad. student, Dept. Ent., K. S. C., Manhattan, Kan.
Fuller, Glen, student, 1937, Bethel College, Kan.
*Gates, F. C., Ph. D., 1922, prof. botany, K. S. C., Manhattan, Kan.
*Gentry, Adrian N., M. A., 1933, Box 433, Seward, Alaska.
*Gessner, B. A., Ph. D., 1937, prof. of psychology, Baker Univ., Baldwin, Kan.
*Gibson, E. Louise, M. A., 1938, assoc. prof. home ec. edu., K. S. T. C., Pittsburg, Kan.
*Gier, L. J., M. S., 1931, Campbell College, Buies Creek, N. C.
Giersch, Sister Crescentia, M. S., 1934, instr. biology, Marymount Col., Salina, Kan.
*Gilbert, Lael O., A. B., 1938, student, F. H. K. S. C., Hays, Kan.
*Gladfelter, C. F., 1936, M. S., instr. agri., 1012 Market St., Emporia, Kan.
Glover, J. A., A. B., 1934, chemistry, H. S. North, Wichita, Kan.
Goff, Richard, 1937, student, Dept. of Zoölogy, U. of Oklahoma, Norman, Okla.
Good, Newell E., 1936, Fourteenth Avenue and Make street, U. S. Public Health Serv. Lab., San Francisco, Cal.
*Good, Wilfred M., A. B., 1938, asst. instr., U. of K., Lawrence, Kan.
*Gooden, Don., B. S., 1938, principal Jr. H. S., Mound City, Kan.
*Gordon, Carl E., 1938, student, Southwestern College, Winfield, Kan.
*Gordon, Glen H., A. B., 1938, geologist Magnolia Petroleum Co., 153 S. Volutsia, Wichita, Kan.
*Gorham, Maude I., A. M., 1936, prof., F. H. K. S. C., Hays, Kan.
*Graham, Edward W., B. S., 1938, grad. student, K. S. T. C., Pittsburg, Kan.
*Gray, William H., 1937, Dept. Psychology, K. S. T. C., Emporia, Kan.
*Griffith, Melvin E., A. M., 1938, fellow, U. of K., 310 Snow Hall, Lawrence, Kan.
*Grimes, Waldo E., Ph. D., 1925, head Dept. Agri. Econ., K. S. C., Manhattan, Kan.
*Griner, A. J., 1931, 417 E. Thirteenth street, Kansas City, Mo.
*Groody, Thomas C., M. S., 1936, instr. zoölogy, K. S. C., Manhattan, Kan.
*Guthridge, L. A., M. S., 1938, registrar, K. S. T. C., Pittsburg, Kan.
Hadley, John M., A. B., grad. 1937, student, F. H. K. S. C., Hays, Kan.
*Haggart, Margaret H., M. A., 1932, head Home Ec. Dept., F. H. K. S. C., Hays, Kan.
*Hall, H. H., Ph. D., 1934, prof. biology, K. S. T. C., Pittsburg, Kan.
Hallsted, Alanson L., 1929, Ft. Hays Exp. sta., Assoc. agronomist, U. S. D. A., Hays, Kan.
*Hankammer, Otto A., Ph. D., 1938, prof. ind. edu., K. S. T. C., Pittsburg, Kan.
*Hancin, John, 1931, 1114½ S. Fifth, Salina, Kan.
*Hansing, Earl D., M. S., 1936, Dept. Plant Pathology, Cornell Univ., Ithaca, N. Y.
*Hanson, Hugh, 1936, student, K. S. T. C., Emporia, Kan.
*Harbaugh, M. J., M. S., 1930, asst. prof. zoölogy, K. S. C., Manhattan, Kan.
Harris, C. L., Ph. M., 1928, attorney at law, Box 1088, El Dorado, Kan.
*Hartel, Lawrence W., M. S., 1930, asst. prof. physics, K. S. C., Manhattan, Kan.
*Harvard College Library, 1930, Cambridge, Mass.
Hawkins, Paul, 1936, prin. El Dorado Jr. H. S., El Dorado, Kan.
Haymaker, H. H., Ph. D., 1937, prof. botany, K. S. C., Manhattan, Kan.
*Heckert, L. C., Ph. D., 1938, prof. of chemistry, K. S. T. C., Pittsburg, Kan.
*Henry, Edwin R., Ph. D., 1927, asst. prof. psychology, New York Univ., Univ. Heights, New York, N. Y.
*Herbertson, James E., M. S., 1934, Zoöl. Dept., Univ. of Oregon, Eugene, Ore.
*Hermanson, Joe L., Ph. D., 1937, asst. prof. chem., Bethany Col., Lindsborg, Kan.
*Herrick, Earl H., Ph. D., 1927, 1934, assoc. prof. zoölogy, K. S. C., Manhattan, Kan.
*Hershey, J. Willard, Ph. D., 1920, prof. chemistry, McPherson College, McPherson, Kan.
*Hertzler, Arthur E., M. D., Ph. D., 1928, 327 Chestnut-Hertzler Clinic, Halstead, Kan.

*Hess, Robert H., M. A., 1938, chemist, Kansas State Board of Health, Lawrence, Kan.
*Hibbard, Claude, W., A. M., 1938, Dept. Paleontology, U. Mus., Lawrence. Kan. [Forward]
*Higbie, Walter, Ph. B., 1934, chemist, Hercules Powder Co., Kalamazoo, Mich.
Hill, Mrs. Noblesse DeMoss, M. S., 1936, 315 Yuma St., Manhattan, Kan.
*Hilt, Wilma M., M. S., 1937, Sabetha, Kan.
*Hilton, Willard, A. B., 1937, 3009 Clark Court, Topeka, Kan.
*Hodge, Harold C., Ph. D., 1931, School of Medicine, Univ. Rochester, Rochester, N. Y.
*Holt, Wendell L., B. S., 1938, student, Bethany College, Lindsborg, Kan.
Hoover, F. S., M. A., 1937, 1428 S. Forty-second St., Kansas City, Kan.
*Hopkins, J. Frank, B. S., 1937, 415 S. Broadway, Pittsburg, Kan.
Horne, LeRoy W., B. S., 1937, Dept Chem., K. S. C., Manhattan, Kan.
*Horner, Sister Agnes Marie, A. M., 1937, St. Mary College, Leavenworth, Kan.
*Horner, Seward E., B. S., 1938, geologist, Abilene, Kan.
*Horr, W. H., Ph. D., 1933, assoc. prof. botany, U. of K., Lawrence, Kan.
*Horton, John R., B. S., 1922, 437 S. Fountain Ave., Wichita, Kan.
*Hoyle, William Luther, M. S., 1934, Bavaria High School, Bavaria, Kan.
Hudiburg, Leo E., M. S., 1931, asst. prof. physics, K. S. C., Manhattan, Kan.
*Hungerford, H. B., Ph. D., 1920, head, Dept. Ent., U. of K., Lawrence, Kan.
*Hurd, Myron A., M. S., 1937, address unknown.
*Hutchison, Frances S., M. S., 1932, instr. biology, J. S. and Jr. Col, El Dorado, Kan.
*Ibsen, Heman L., Ph. D., 1922, prof. genetics, Dept. of Animal Husb., K. S. C., Manhattan, Kan.
Irvin, Charles Verner, B. S., 1934, address unknown.
*Jacobson, Leone, Ph. B., 1938, psychometrist, Wichita Child Research Lab., 613 S. Market St., Wichita, Kan.
*Jensen, Carey M., Ph. D., 1938, prof. math., Kansas Wesleyan College, Salina, Kan.
Jewell, Minna E., Ph. D., 1925, prof. zoöl., Thornton Jr. Col., Harvey, Ill.
*Jewett, J. M., A. C., 1933, Geological Survey, U. of K., Lawrence, Kan.
*Johnson, Carl E., B. S., 1938, student, Bethany Col., Lindsborg, Kan.
*Johnson, Kenneth L., B. S., 1938, asst. prof. biology, Bethany Col., Lindsborg, Kan.
*Johnson, Wendell L., B. S., 1938, grad. student, Erie, Kan.
*Johnston, C. O., M. S., 1928, assoc. plant pathologist, K. S. C., Manhattan, Kan.
*Jones, Elmer T., A. M., 1932, asst. ent., U. S. D. A., 1204 Fremont street, Manhattan, Kan.
*Jones, E. W., M. S., 1938, assoc. prof. physical science, 1719 S. Olive street, Pittsburg, Kan.
Jones, J. Russell, 1937, student, Sterling Col., Sterling, Kan.
*Jones, Ogden S., A. B., 1937, 1633 Boswell, Topeka, Kan.
*Jordan, Genevieve, B. S., 1938, student, K. S. T. C., Pittsburg, Kan.
*Justin, Margaret M., Ph. D., 1925, dean, Div. Home Ec., K. S. C., Manhattan, Kan.

JUNIOR ACADEMY OF SCIENCE CLUBS:

*Arkansas City Junior High School Science Club, 1938, Robley C. Guy, sponsor, Arkansas City, Kan.
*Arkansas City Science Club, 1938, C. E. Ruff, sponsor, Arkansas City, Kan.
*Bavaria H. S. Junior Science Club, 1938, W. L. Hoyle, sponsor, Bavaria, Kan.
*Ben Franklin Club, 1935, Liberty Memorial H. S., Lawrence, Kan.
*Cherryvale S. F. A. Science Club, 1938, Warren Willey, sponsor, Cherryvale, Kan.
*Columbus H. S. Jr. Science Club, 1938, K. A. McClure, sponsor, Columbus, Kan.
*Fort Scott High School Science Club, 1938, Ross Anderson, sponsor, Fort Scott, Kan.
*Galena High School Science Club, 1938, Robert Troughton, sponsor, Galena, Kan.
*Independence General Science Club, 1938, Parley W. Dennis, sponsor, Independence, Kan.
*Iola Jr. High Science Club, 1938, Seth J. Owens, sponsor, Iola, Kan.
*Junction City Jr. Sr. High Science Club, 1934, H. R. Callahan, sponsor, Junction City, Kan.
*Lawrence Junior High School Nature Club, 1932, Miss Edith Beach, sponsor, Lawrence, Kan.
*Manhattan High School Science Club, 1938, Ralph Rogers, sponsor, Manhattan, Kan.
*Pittsburg College High Science Club (Pi Kappa Epsilon Club), 1937, J. A. Trent, sponsor, K. S. T. C., Pittsburg, Kan.
*Pittsburg H. S. Jr. Academy, 1938, Claude I. Huffman, sponsor, Pittsburg, Kan.
*Pittsburg, S. O. S. Science Club, 1938, J. Frank Hopkins, sponsor, Lakeside Jr. High, Pittsburg, Kan.
*Wichita East High Chemistry Club, 1934, J. A. Brownlee, sponsor, Wichita High School East, Wichita, Kan.

*Kansas City Public Library, 1930, Kansas City, Mo.
*Kansas Wesleyan Library, 1938, Salina, Kan.
*Kaufman, Clemens M., A. B., 1935, Moundridge, Kan.
*Keller, Pauline, B. S., 1938, grad. student, 205 E. Cleveland, Pittsburg, Kan.
*Kelly, E. G., Ph. D., 1935, extension entomologist, K. S. C., Manhattan, Kan.
*Kent, C. V., Ph. D., 1936, Dept. Physics, U. of K., Lawrence, Kan.
Keroher, Grace, A. B., 1937, grad. student, U. of K., Lawrence, Kan.
Keroher, Raymond, A. B., 1937, grad. student, U. of K., Lawrence, Kan.
*Kerr, W. H., 1935, 1401 Stone street, Great Bend, Kan.
*Kester, Frederick E., Ph. D., 1929, prof. physics, U. of K., Lawrence, Kan.
*Kilkenny, Mary Cecelia, B. S., 1938, 914 Division street, Atchison, Kan.
Kimpel, Ben F., Ph. D., 1937, address unknown.
*Kingsley, Eunice L., M. S., 1933, instr. botany, K. S. C., Manhattan, Kan.
*Kinney, Edward D., B. S., 1930, assoc. prof. and head, Dept. Chemical Engineering, U. of K., Lawrence, Kan.
*Kirgis, Homer D., M. S., 1937, Dept. Micro-anatomy, Saint Louis Univ. School of Medicine, 1402 S. Grand Blvd., St. Louis, Mo.
*Kirkpatrick, Ernest L., A. B. and B. S., 1934, Madison, Kan.
*Kitchen, Mary Elizabeth, B. S., 1924, 1935, Librarian Phillips Univ., Enid, Okla.
Kleihege, J. B., 1937, real estate agent, 404 W. Seventeenth street, Kansas City, Mo.
*Knowlton, Reginald, 1937, student, Friends Univ., Wichita, Kan.
*Koopman, Richard J. W., M. S., 1938, asst. prof. electrical engineering, U. of K., Lawrence, Kan.
*Kramer, Martha M., Ph. D., 1925, 1932, prof. food econ. and nutrition, K. S. C., Manhattan, Kan.
Kroeker, E. H. Ph. D., 1936, 5222 Sylvester, Philadelphia, Pa.
*Kunerth, Bernice, M. S., 1933, instr. food econ. and nutrition, K. S. C., Manhattan, Kan.
*Kuntz, James E., B. S., 1938, grad. student, F. H. K. S. C., 429 W. Eleventh, Hays, Kan.
*Lahr, E. L., M. S., 1932, Dept. Genetics, Cold Springs Harbor, Long Island, N. Y.
*Landes, Kenneth K., Ph. D., 1931, asst. state geologist, U. of K., Lawrence, Kan.
*Lane, Charles E., Ph. D., 1937, asst. prof. zoölogy, Univ. Wichita, Wichita, Kan.
*Lane, H. H., Ph. D., 1938, head, Dept. Zoölogy, Lawrence, Kan.
*Langford, Roy C., Ph. D., 1938, Dept. Psychology, K. S. C., Manhattan, Kan.
*Larson, Mary E., A. M., 1925, asst. prof. zoölogy, U. of K., Lawrence, Kan.
*Latimer, Homer B., Ph. D., 1928, prof. anatomy, U. of K., Lawrence, Kan.
*Latta, Bruce F., 1937, student, 1529 Kentucky, Apt. 108, Lawrence, Kan.
*Lawson, Paul B., Ph. D., 1919, dean, liberal arts and prof. entomology, U. of K., Lawrence, Kan.
*Lefebvre, C. L., Ph. D., 1933, Arlington Farm, Arlington, Va.
*Leist, Claude, M. A., 1929, assoc. prof. biology, K. S. T. C., Pittsburg, Kan.
Light, M. B., 1937, retired banker, E. Tenth Ave., Winfield, Kan.
Lindley, E. H., Ph. D., LL. D., 1923, chancellor, U. of K., Lawrence, Kan.
*Lippert, Robert D., 1938, student, Bison, Kan.
*Lippert, Verne, M. S., 1935, Bison, Kan.
*Litwiller, Raymond, Ph. D., 1938, Biology Dept., Kansas Wesleyan Univ., Salina, Kan.
*Lockard, Gene K., B. S., 1937, Burden, Kan.
*Lockhart, Charles H., B. S., 1938, grad. asst. K. S. C., Manhattan, Kan.
*Loewen, S. L., M. A., 1931, head Dept. of Biology, Sterling College, Sterling, Kan.
*Lommasson, Robert C., 1938, asst. instr. in botany, 1142 Indiana, Lawrence, Kan.
*Long, Walter S., Ph. D., 1929, head Chemistry Dept., Kansas Wesleyan College, Salina, Kan.
*Love, Glenn Harvey, 1938, student K. S. T. C., Emporia, Kan.
*Lyon, Eric R., M. S., 1926, assoc. prof. physics, Box 806, K. S. C., Manhattan, Kan.
*Lyon, Jeanne, M. S., 1930, Box 335, Maryville, Mo.
*Mac Farquhar, Wm. K., A. B., 1938, Dept. Geology, U. of K., Lawrence, Kan.
McCullough, A. W., A. B., 1934, Dept. Zoölogy, U. of K., Lawrence, Kan.
*McDonald, Clinton C., Ph. D., 1928, prof. botany, Univ. of Wichita, Wichita, Kan.
McElray, Abigail, M. S., 1935, instr. biology, H. S., Topeka, Kan.
McGehee, Frances, Ph. D., 1937, Child Res. Lab., Friends Univ., Wichita, Kan.
*McGuire, Paul, 1938, Route 2, Fairfax, Okla.

*McKinley, Lloyd, Ph. D., 1928, 1937, Univ. Wichita, Wichita, Kan.
*McLaughlin, Thad G., A. B., 1937, Dept. of Geo., U. of K., Lawrence, Kan.
*McMillen, J. Howard, Ph. D., 1938, assoc. prof. K. S. C., 1130 Bertrand, Manhattan, Kan.
McNaio, Mrs. Ruth K., 1937, instr. zoölogy, U. of K., 1624 Alabama, Lawrence, Kan.
*McNeil, Mellicent, Ph. D., 1938, head Eng. Dept., K. S. T. C., Pittsburg, Kan.
*McWilliams, Bess, M. E., 1938, instr., Jr. High School, Fort Scott, Kan.
*Mackintosh, David L., M. S., 1936, assoc. prof. animal husbandry, K. S. C., Manhattan, Kan.
*Marsh, Richard R., M. S., 1938, asst, prof. of biology, Baker Univ., Baldwin, Kan.
*Marshall, Josephine A., M. A., head Dept. of Home Economics, K. S. T. C., Pittsburg, Kan.
Mason, Harry, 1937, Div. of Edu. and Applied Psychology, Purdue, Univ., Lafayette, Ind.
Massachusetts Institute of Technology Lib., Cambridge, Mass.
*Matter, W. E., B. S., 1938, assoc., prof. of sec. edu., 704 Woodland, Pittsburg, Kan.
Matthews, Wm. H., M. S., 1920, assoc. prof. physics, K. S. T. C., Pittsburg, Kan.
*Maxwell, Geo. W., M. S., 1929, asst. prof. physics, K. S. C., Manhattan, Kan
*Mayberry, M. W., M. A., 1933, asst. instr. botany, U. of K., Lawrence, Kan.
*Mayerus, Miss Margaret, B. S., 1938, Mt. Scholastica College, Atchison, Kan.
Melchers, Leo Edward, M. S., 1918, head Dept. Botany and Plant Path., K. S. C., Manhattan, Kan.
Merchant, Frank E., A. B., 1937, asst. prof. geol., U. of K., Lawrence, Kan.
*Merrill, Joseph F., B. S., 1937, asst. chemist, K. S. C., Manhattan, Kan.
Michaelson, Louis, 1936, student, Wichita Univ., Wichita, Kan.
*Michener, John M., M. S., 1925, head Science Dept. H. S., East, Wichita, Kan.
Mikesell, William Henry, 1937, ch. Dept. of Psychology, U. of Wichita, Wichita, Kan.
*Miller, Edwin Cyrus, Ph. D., 1918, prof. botany, K. S. C., Manhattan, Kan.
Miller, R. F., Ph. D., 1928, prof. physics, College of Emporia, Emporia, Kan.
*Mitchell, U. G., Ph. D., 1931, prof. mathematics, U. of K., Lawrence, Kan.
*Mix, Arthur J., Ph. D., 1931, prof. botany, U. of K., Lawrence, Kan.
Mohler, R. E., M. S., 1929, prof. biology, McPherson College, McPherson, Kan.
*Moore, Raymond C., 1934, geologist, U. of K., Lawrence, Kan.
*Morgan, L. C., B. S., 1938, Engineer, geologist, 207 Ellis, Singleton Bldg. Wichita, Kan.
*Moss, W. Glen, B. A., 1938, lab. asst. in zoölogy, U. of Wichita, Wichita, Kan.
*Murphy, Paul, Ph. D., 1933, prof. psychology, K. S. T. C., Pittsburg, Kan.
Myers, Robert, 1937, address unknown.
*Nagge, Joseph W., Ph. D., 1935, asst. prof. psychology, K. S. T. C., Emporia, Kan.
Nash, Bert A., Ph. D., 1930, prof. edu. and dir. Edu. Clinic, U. of K. Lawrence, Kan.
Nelson, Esther B., M. S., 1937, assoc. prof. chem., K. S. C., Manhattan, Kan.
*Newcomb, Margaret, M. S., 1937, asst. prof. botany, K. S. C., Manhattan. Kan.
*Newton, James T., M. S., 1938, Douglass, Kan.
Newell, N. D., Ph. D., 1937, dept. geology, Science Hall, Univ. of Wis. Madison, Wis.
*Nibarger, Agnes, M. S., 1938, asst. in chem., 1437 S. St. Francis, Wichita, Kan.
Nill, (Mrs.) Coyle Wellman, 1935, address unknown.
Nininger, H. H., A. M., 1921, 635 Fillmore street, Denver, Colo.
*Obee, Donald J., M. A., 1933, asst. instr. botany, U. of K., Lawrence, Kan.
*Old, Edna, M. A., 1935, Botany Department, U. of K., Lawrence, Kan.
*Olsen, Allen L., Ph. D., 1935, instr. chem., K. S. C., Manhattan, Kan.
*Oncley, Lawrence, Ph. D., 1933, head Physical Sc. and Math., Southwestern College, Winfield, Kan.
*Oregon State College Library, 1930, Corvallis, Ore.
*Osborn, Ben., B. S., 1937, asst. regional biologist, Soil Conservation Service, Salina, Kan.
*Osborn, Courtney D., A. B., 1938, asst. instr., U. of Wichita, Wichita Kan.
Owen, Fayette T., Ph. D., 1931, prof. chem., College of Emporia, Emporia, Kan.
*Pady, Stuart, Ph. D., 1937, prof. botany, Ottawa Univ., Ottawa, Kan.
*Painter, Reginald, Ph. D., 1927, assoc. prof, entomology, K. S. C., Manhattan, Kan.
*Palmer, Martin F., Sc. D., 1938, University of Wichita, Wichita, Kan.
Panhaskie, Margaret, A. B., 1937, Custer Hall, F. H. K. S. C., Hays, Kan.
*Parker, John H., Ph. D., 1918, prof. crop imp., Dept. Agron., K. S. C., Manhattan, Kan.
*Parker, Laurence, M. S., 1938, State Supervisor, K. S. T. C., Pittsburg, Kan.
*Parker, Mary Ellen, A. M., 1938, 1251 Central Ave, Kansas City, Kan.
*Parks, W. B., Ph. D., 1931, prof. chem., K. S. T. C., Pittsburg, Kan.
*Paul, Joseph W., B. S., 1938, asst. supervisor Trade and Ind. Ed., Pittsburg, Kan.
*Payne, Sister Mary Anthony, Ph. D., 1930, Mt. St. Scholastica, Atchison, Kan.

Perkins, Alfred T., Ph. D., 1925, 1929, 1931, asst. prof. chem., K. S. C., Manhattan, Kan.
*Perrine, Irving, Ph. D., 1921, oil operator, geologist, 1619-29 Petroleum Building, Oklahoma City, Okla.
Peterka, Harry, M. A., 1933, High School, Okmulgee, Okla.
*Peterson, J. C., Ph. D., 1919, prof. psychology, K. S. C., Manhattan, Kan.
*Peterson, Oscar J., Ph. D., 1936, head Dept. Math., K. S. T. C., Emporia, Kan.
Peterson, Walter J., Ph. D., 1937, asst. nutrition chemist, K. S. C., Manhattan, Kan.
Pinner, Bert, 1937, Box 3, U. of K., Lawrence, Kan.
*Pittman, Martha S., Ph. D., 1925, 1931, prof. food econ. & nutrition, K. S. C., Manhattan, Kan.
*Plum, W. B., Ph. D., 1937, Dept. Math. and Physics, Southwestern College, Winfield, Kan.
Ponder, L. H., grad. student, 1937, Dept. Zoölogy, U. of K., Lawrence, Kan.
*Poos, Frederick W., Ph. D., 1937, Arlington Lab. U. S. Bur. Ent., Arlington, Virginia.
*Portman, Roland W., B. S., 1938, grad. student, K. S. C., Manhattan, Kan.
*Potter, Blendena, B. S., 1938, student, Mound City, Kan.
*Prather, Paul E., 1938, student, McPherson College, McPherson, Kan.
Pretz, Paschal H., M. S., 1930, prof. physics, St. Benedict's College, Atchison, Kan.
*Price, G. Baley, Ph. D., 1938, asst. prof. math., U. of K., Lawrence, Kan.
*Prince, S. Fred, 1938, biological artist, Galena, Mo.
*Proietto, Lillian J., Ph. D., 1937, head Biology Dept., St. Mary College, Leavenworth, Kan.
*Provorse, Leonard R., 1938, student, 1923 S. Elm, Pittsburg, Kan.
Pullam, A. E., A. B., 1937, grad. student, dept. zoölogy, U. of K., Lawrence, Kan.
*Pyle, C. B., Ph. D., (renewal 1937), head Psychology and Philosophy K. S. T. C., Pittsburg, Kan.
*Rachaner, Sister Germaine, B. S., 1938, St. Scholastica Convent, Fort Smith, Ark.
*Rankin, Roy, M. A., 1919, chem. and chairman Div. Sci. F. H. K. S. C., Hays, Kan.
*Rarick, C. E., Ph. D., 1935, president, F. H. K. S. C., Hays, Kan.
Rarick, Lawrence, M. S., 1936, Univ. of Wichita, Wichita, Kan.
*Reardon, Anna J., Ph. D., 816A State St., East St. Louis, Ill.
*Reed, Homer B., Ph. D., 1936, prof. psych. F. H. K. S. C., Hays, Kan.
Reid, W. Malcolm, B. S., 1936, Dept. Zoölogy, Brown Univ., Providence, R. I.
*Rickard, Brooks C., 1936, Medicine Lodge, Kan.
Rizzo, Nicholas D., M. D., 1936, address unknown.
*Riddell, W. H., Ph. D., 1938, assoc. prof. dairy husbandry, K. S. C., Manhattan, Kan.
*Roberts, Eugene C., B. S., 1938, student, K. S. T. C., 2003 S. Locust, Pittsburg, Kan.
*Rogers, Cornelius R., A. B., 1935, 339½ N. Poplar, Wichita, Kan.
Rolfs, Marvin E., M. S., 1937, instr. physics, Dodge City Jr. Col., Dodge City, Kan.
*Ross, Bennington, B. S., 1938, grad. student, Rt. 4, Pittsburg, Kan.
*Rouse, James E., M. S., 1928, prof. agric., F. H. K. S. C., Hays, Kan.
*Royce, Clare H., B. S., 1938, 403 W. Seventh St., Langdon, Kan.
*Royer, W. D., A. B., 1927, 1938, instr. in physiology and biology, 325 Madison, Wichita, Kan.
Ruff, Charles E., B. S., High School, Arkansas City, Kan.
*Ruggles, George E., M. S., 1936, K. S. T. C., Pittsburg, Kan.
*Rupe, L. Odus, 1938, student, Sterling, Kan.
*Saffry, Olga B., M. S., 1937, Dept. Zoölogy, K. S. C., Manhattan, Kan.
*Sanders, Ottys, A. B., 1934, president Southwestern Biol. Sup. Co., P. P. Box 4084, Dallas, Tex.
*Schaefer, Helen I., B. S., 1935, 1220 Market St., Emporia, Kan.
*Schaffner, D. C., A. M., 1931, geology and botany, 826 Rural St., Emporia, Kan.
Schmidt, J. M., 1934, 1937, Tabor College, Hillsboro, Kan.
*Schmidt, Lillian, M. S., 1938, K. S. T. C., Pittsburg, Towanda, Kan.
*Schoewe, Walter H., Ph. D., 1925, Dept. of Geology, U. of K., Lawrence, Kan.
*Schovee, Joseph C., 1928, assist. eng., A. T. & S. F. Ry. Co., 1235 Boswell, Topeka, Kan.
Schrader, William B., M. S., 1937, instr. Dept. Education, K. S. C., Manhattan, Kan.
*Schrammel, H. E., Ph. D., 1929, prof. psychology, K. S. T. C., Emporia, Kan.
*Schultz, P. D., M. S., 1937, Dept. Chem., Friends Univ., Wichita, Kan.
*Schumann, Margaret, M. A., 1922, technician, Anatomy Dept., U. of K., Lawrence, Kan.
Schwartz, J. D., M. S., 1937, Dept. Biochem., Dodge City Jr. Col., Dodge City, Kan.
*Schwauzle, R. L., M. S., 1938, ind. arts, 408 W. Adams St., Pittsburg, Kan.
*Seaton, Roy A., M. S., 1929, dean, Div. Engineering, K. S. C., Manhattan, Kan.
*Sewell, Nila Allen, B. S., 1938, student, Rt. 3, Parsons, Kan.

*Shaffer, Allen H., M. S., 1938, science teacher, Kingman High School, Kingman, Kan.
Shaffer, H. Lloyd, A. B., 1931, 506 Simpson Bldg., Ardmore, Okla.
*Shepherd, Byron L., M. S., 1938, 1239 S. Atlanta Ave., Tulsa, Okla.
*Shepherd, Harold R., A. B., 1938, grad. student, F. H. K. S. C., Hays, Kan.
Sherwood, Noble P., Ph. D., 1935, prof. bacteriology, U. of K., Lawrence, Kan.
Sites, Blaine E., B. S., 1932, teacher physics and chemistry, H. S., Salina, Kan.
Smedley, Melbern, student, 1936, address unknown.
Smith, Charles Lewis, 1937, student, K. S. T. C., Emporia, Kan.
*Smith, H. T. U., Ph. D., 1937, Geol. Dept., U. of K., Lawrence, Kan.
*Smith, Harry H., M. S., 1938, Dept. of Animal Hus., K. S. C., Manhattan, Kan.
*Smith, Hobart M., M. S., 1932, Dept. Zoölogy, U. of Michigan, Ann Arbor, Mich.
*Smith, Roger C., Ph. D., 1921, prof. ent., K. S. C., Manhattan, Kan.
*Smith, R. G., Ph. D., 1938, prof. mathematics, Pittsburg, Kan.
*Smith, Steve, 1938, mgr. Photographic Dept., Hall's Topeka, 623 Kansas Ave., Topeka, Kan.
*Smith, V. T., Ph. D., 1937, Kansas Wesleyan Univ., Salina, Kan.
Sperry, Arthur B., B. S., 1917, 1922, prof. geology, K. S. C., Manhattan, Kan.
*Sprague, James M., A. B., 1938, 1540 New Hampshire, Lawrence, Kan.
*Stark, Frank L., B. S., 1938, Junior High and Grade Principal, Cedarvale, Kan.
*Stebbins, Florence M., M. S., 1938, asst. genetics, K. S. C., Manhattan, Kan.
*Stephens, Homer A., B. S., 1936, 820 Santa Fe, Atchison, Kan.
*Stephenson, Lyle A., 1932, 118 E. Tenth St., Kansas City, Mo.
*Sternberg, Charles W., 1936, 6146 Dorchester Ave., Chicago, Ill.
*Sternberg, George F., M. S., 1928, Field vertebrate paleontologist, F. H. K. S. C., Hays, Kan.
*Stewart, Troy J., B. A., 1938, student, 141 N. Hillside, Wichita, Kan.
*Stockebrand, F. C., B. S., 1938, teacher biology, Fort Scott, Kan.
*Stogsdill, J. W. E., A. B., 1929, 1937, Dept. Physics, East High School, Wichita, Kan.
*Stouffer, E. B., Ph. D., 1929, dean, Grad. School, U. of K., Lawrence, Kan.
Stout, Eva, 1937, Field visitor, 1825 Maple, Wichita, Kan.
*Street, C. W., Ph. D., 1938, head, Dept. Education, K. S. T. C., Pittsburg, Kan.
Stroud, J. B., Ph. D., 1932, Dept. Psychology and Philosophy, K. S. T. C., Emporia, Kan.
*Studt, Charles W., M. S., 1928, Sagamore Oil & Gas Co., Independence, Kan.
*Summerland, S. A., M. S., 1937, U. S. D. A., 808 State St., Vincennes, Ind.
*Sutter, L. A., M. D., 1923, Physician, 611 First National Bank Bldg., Wichita, Kan.
Swain, Fred M., A. B., 1937, 1046 Tennessee St., Lawrence, Kan.
*Swanson, Arthur F., M. S., 1926, agronomist, Branch Exp. Sta., Hays, Kan.
*Taft, Robert, Ph. D., 1923, 1929, assoc. prof. chem., U. of K., Lawrence, Kan.
Talbott, W. A., Jr., 1935, 411 Pearl St., Joplin, Mo.
*Taylor, Edward H., Ph. D., 1928, assoc. prof. zoölogy, U. of K., Lawrence, Kan.
*Teller, James H. D., Ph. D., 1938, instr. mathematics, F. H. K. S. C., Hays, Kan.
Terry, Lyman, 1937, student, U. of K., Lawrence, Kan.
Thomas, George L., Jr., A. B., 1937, Dept. Chem., F. H. K. S. C., Hays, Kan.
Thomas, L. C., Ph. D., 1932, address unknown
*Thompson, D. Ruth, M. A., 1928, prof. of chem., Sterling College, Sterling, Kan.
*Thompson, Rufus H., M. A., 1934, Dept. Botany, U. of K., Lawrence, Kan.
Thomsen, Lillian C., Ph. D., 1937, address unknown.
Tiemeir, Otto W., A. B., 1937, museum asst., U. of K., Lawrence, Kan.
Tihen, Joe A., 1936, Harper, Kan.
*Todd, Arlie, A. B., 1938, res. asst. zoölogy, K. S. C., Manhattan, Kan.
*Torstveit, Olaf, M. S., 1937, Dept. Zoölogy, U. of Wis., Madison, Wis.
Travis, Gerald, B. S., 1937, principal, Norton H. S., Norton, Kan.
*Trent, J. A., A. M., 1934, asst. prof. biology, K. S. T. C., Pittsburg, Kan.
Trimmell, John A., M. S., 1936, Box 718, Great Bend, Kan.
*Tuck, J. B., 1938, Dept of Ent., K. S. C., Manhattan, Kan.
*Tucker, Charles B., M. S., 1938, instr. math., K. S. T. C., Emporia, Kan.
*Tusler, Orlando, C., B. S., 1938, 1042 N. Broadway, Wichita, Kan.
*Uhrich, Jacob, Ph. D., 1938, instr. zoölogy, K. S. T. C., Pittsburg, Kan.
Unruh, Earl W., 1937, student, address unknown.
*Vandervelde, Conrad, D. D., 1937, dean psychology, College of Emporia, Emporia, Kan.
Voth Albert C., 1936, Dept. Psychology, U. of K., Lawrence, Kan.
*Wadley, F. M., Ph. D., 1938, U. S. Bur. Ent. and Pl. Quar., U. S. D. A., Washington, D. C.
*Wagoner, C. E., 1938, student, McPherson College, McPherson, Kan.

*Walkden, H. H., B. S., 1938, U. S. D. A., Bur. Ent. and Pl. Quar., 1204 Fremont St., Manhattan, Kan.
Walter, Philip, B. S., 1937, grad. student, Dept. Geology, K. S. C., Manhattan, Kan.
*Waring, Sister Mary Grace, Ph. D., 1932, head Science Dept., Marymount College, Salina, Kan.
*Warner, Robert W., E. E., 1935, head Dept. Elect. Engr., U. of K., Lawrence, Kan.
Warnock, W. G., Ph. D., 1936, asst. prof. math., F. H. K. S. C., Hays, Kan.
Washburn, E. Roger, Ph. D., 1937, prof. chem., U. of Neb., Lincoln, Neb.
Way, P. Ben, B. S., 1932, High School north, Wichita, Kan.
*Weathers, Edra, A. B., 1936, Wichita Child Res. Lab., Wichita, Kan.
Weaver, Virgil L., B. S., 1937, General Electric Co., Schenectady, N. Y.
*Weber, Arthur D., M. S., 1937, Dept. Animal Hus., K. S. C., Manhattan, Kan.
*Weber, Clement, 1928, Box 186, Selden, Kan.
*Weber, Louis R., Ph. D., 1929, head Physics Dept., Friends Univ., Wichita, Kan.
*Weeks, Elvira, Ph. D., 1927, asst. prof. chem., U. of K., Lawrence, Kan.
*Weidlein, Edward Ray, Sc. D., LL. D., 1911, dir. Mellon Inst., Mellon Institute, Pittsburgh, Pa.
*Weishapl, Catherine, B. S., 1938, Herndon, Kan.
*West, Marion C., 1938, Dept. Ent., K. S. C., Manhattan, Kan.
*Wetmore, Alexander, 1935, asst. sec. Smithsonian Inst., U. S. Nat. Museum, Washington, D. C.
*Wheatley, Max D., A. B., 1938, asst. instr., Dept. Zoölogy, U. of K., Lawrence, Kan.
*Wheeler, Raymond H., Ph. D., 1936, prof. and head Dept. Psychology, U. of K., Lawrence, Kan.
*White, June, B. S., 1938, 2110 W. Garfield Blvd., Chicago, Ill.
*Whitla, Raymond E., A. B., 1937, asst. prof. geol., U. of K., Lawrence, Kan.
Whitnah, Carroll H., Ph. D., 1936, chemist, K. S. C., Manhattan, Kan.
*Whitney, Marion I., Ph. D., 1938, asst. prof. of geology, K. S. T. C., Pittsburg, Kan.
*Wichita City Library, 1932, Ruth E. Hammond, librarian, Wichita, Kan.
*Wilbur, Donald A., A. M., 1934, asst. prof. ent., K. S. C., Manhattan, Kan.
Wildish, Myra, A. B., 1936, 115 N. Lawn St., Kansas City, Mo.
*Wimmer, E. J., Ph. D., 1928, asst. prof. zoöl., K. S. C., Manhattan, Kan.
Wismer, C. A., M. S., 1933, Dept. Plant Pathology, University Farm, St. Paul, Minn.
Witherspoon, Ward, A. B., 1936, address unknown.
Wong, Wai Sing, M. S., 1937, Lingnan Univ., Canton, China.
*Wood, Robert E., M. S., 1930, chemistry, Liberty Memorial H. S., Lawrence, Kan.
*Wooster, L. D., Ph. D., 1924, prof. zoölogy, F. H. K. S. C., Hays, Kan.
*Yoder, Emerson, 1938, student, McPherson College, McPherson, Kan.
*Yoder, Maurice A., M. S., 1938, Hesston, Kan.
*Yoder, J. J., LL. D., 1926, prof. sociology, McPherson Col., McPherson, Kan.
*Young, H. D., 1935, assoc. chemist, U. S. D. A., Manhattan, Kan.
*Zinszer, Harvey A., Ph. D., 1930, prof. physics and astronomy, F. H. K. S. C., Hays, Kan.
*Zinszer, Richard H., Ph. D., 1931, 950 Fries St., Wilmington, Cal.
*Zinszer, Wm. K., A. B., 1938, 401 W. Twelfth St., Hays, Kan.

SEVENTIETH ANNUAL MEETING

KANSAS ACADEMY OF SCIENCE

Kansas State Teachers College, Pittsburg, Kan., March 31, April 1, 2, 1938

OFFICERS OF THE ACADEMY

GEORGE A. DEAN, President, Kansas State College.
W. H. SCHOEWE, President elect, University of Kansas.
H. H. HALL, Vice-President, Kansas State Teachers College, Pittsburg.
ROGER C. SMITH, Secretary, Kansas State College.
H. A. ZINSZER, Treasurer, Fort Hays Kansas State College.

Additional Members of the Executive Council

EXECUTIVE COUNCIL

LAWRENCE ONCLEY, Southwestern College. Term expires 1938.
J. H. DOELL, Bethel College. Term expires 1938.
R. H. WHEELER, University of Kansas. Term expires 1938.

EDITORIAL BOARD

F. C. GATES, Editor, Kansas State College. Term expires 1938.
W. J. BAUMGARTNER, Managing Editor, University of Kansas. Term expires 1940.

ASSOCIATE EDITORS

E. O. DEERE, Bethany College. Term expires 1939.
LOUIS R. WEBER, Friends University. Term expires 1939.
ROBERT TAFT, University of Kansas. Term expires 1938.
G. A. KELLY, Fort Hays Kansas State College. Term Expires 1940.

Chairmen of Sections

MARGARET NEWCOMB, Botany.
LLOYD MCKINLEY, Chemistry.
WARREN KNAUS (deceased), Entomology.
L. C. WOODRUFF, Acting, Entomology.
J. M. JEWETT, Geology.
C. V. KENT, Physics.
O. W. ALM, Psychology.
CLAUDE HIBBARD, Zoölogy.
C. E. BURT, Acting, Zoölogy.
J. R. WELLS, Junior Academy.

STANDING COMMITTEES

Appointed by President Dean

1. COMMITTEE ON ENDOWMENT AND INVESTMENTS:
   H. A. Zinszer, Fort Hays Kansas State College, *Chairman.*
   W. E. Grimes, Kansas State College.
   P. S. Albright, Southwestern College.
   H. J. HARNLY, McPherson College.

2. Committee on Conservation and Ecology:

   W. H. Schoewe, Lawrence, *Chairman.*
   H. H. Hall, Kansas State Teachers College, Pittsburg.
   Willard O. Hilton, Topeka.
   C. O. Johnson, Kansas State College.
   C. E. Burt, Southwestern College.
   W. H. Horr, University of Kansas.
   W. H. Matthews, Kansas State Teachers College, Pittsburg.

3. Junior Academy:

   J. R. Wells, Pittsburg, *Chairman.*
   Edith Beach, Lawrence.
   J. A. Brownlee, Wichita.

4. Coördination of Scientific Groups:

   W. J. Baumgartner, University of Kansas, *Chairman.*
   Walter Warnock, Fort Hays Kansas State College.
   Bernice Kunerth, Kansas State College.
   J. B. Stroud, Kansas State Teachers College, Emporia.
   J. L. Bowman, McPherson College.

5. Committee on State Aid:

   W. J. Baumgartner, University of Kansas, *Chairman.*
   George A. Dean, Kansas State College.

6. Committee on Membership:

   Roger C. Smith, Kansas State College, *Chairman.*
   F. U. G. Agrelius, Kansas State Teachers College, Emporia.
   Hazel Branch, University of Wichita.
   R. H. Kingman, Washburn College.
   Mary Larson, University of Kansas.
   Paul Murphy, Kansas State Teachers College, Pittsburg.
   F. W. Albertson, Fort Hays Kansas State College.

7. Committee on Necrology:

   Roy Rankin, Fort Hays Kansas State College, *Chairman.*
   J. E. Ackert, Kansas State College.
   R. H. Beamer, University of Kansas.

8. Committee to Study Educational Trends in Secondary Schools of the State With Respect to Basic Sciences:

   O. W. Alm, Kansas State College, *Chairman.*
   A. C. Carpenter, Ottawa.
   Miss Dale Zeller, Emporia.

9. Committee on Research Awards:

   L. D. Wooster, Fort Hays Kansas State College, *Chairman.*
   R. Q. Brewster, University of Kansas.
   J. C. Peterson, Kansas State College.

10. Committee to Report on Plan to Publish Nature Hand Books:
    Frank C. Gates, Kansas State College, *Chairman.*
    E. J. Wimmer, Kansas State College.
    W. H. Schoewe, University of Kansas.

11. Committee on Arrangements for the Pittsburg Meeting, Spring of 1938:
    William H. Matthews, *Chairman.*
    Paul Murphy.
    Ernest Bennett.
    O. W. Chapman.
    H. H. Hall.

12. Resolutions Committee:
    Mary T. Harman, Kansas State College, *Chairman.*
    R. E. Mohler, McPherson.
    Paul Murphy, Pittsburg.

13. Auditing Committee:
    Geo. Kelly, Hays, *Chairman.*
    Arthur Swanson, Hays.
    Claude Leist, Pittsburg.

14. Nominating Committee:
    Lawrence Oncley, Winfield, *Chairman.*
    J. E. Ackert, Manhattan.
    O. P. Dellinger, Pittsburg.

PROGRAM OUTLINE

THURSDAY, MARCH 31

6:30 p. m. Dinner, Southeast Kansas Section of the Amer. Chem. Soc.

8:00 p. m. Music Hall. Lecture by Dr. Leo Christiansen, President Kansas Chemurgic Council, Atchison. Subject: "Farm Chemurgic." Under the auspices of the Southeast Kansas Section of the American Chemical Society and the Kansas Academy of Science. Reception after the lecture for all members and visitors.

FRIDAY, APRIL 1

8:30—9:30 a. m. General Session. Science Hall, room 210. Announcements, appointments of committees and reports of officers.

10:00—12:00. Demonstrations and exhibits, Science Hall, room 112.

Section Programs:

Botany, Science Hall, room 203.

Zoölogy, Science Hall, room 211.

Geology, Mine Building Lecture Room.

Psychology, Russ Hall, room 315.

1:00—5:30 p. m. Section Programs, Botany, Zoölogy, and Psychology continued from morning.

Chemistry, Carney Hall, room 211.

Physics, Mechanical Arts Building.

2:00 p. m. Junior Academy of Science Meeting, room 205 (Physics classroom) Mechanical Arts Building.

Field trips to be announced.

6:15 p. m. Banquet, College Cafeteria.

Toastmaster—Dr. W. H. Schoewe.

Address of Welcome—Pres. W. A. Brandenburg, K. S. T. C., Pittsburg.

Presidential address—Pres. George A. Dean, Head, Dept. of Entomology and State Entomologist, Kans. State College of Agr. and Applied Science, Manhattan, "Contributions to Entomology from the State of Kansas."

8:00 p. m. Lecture by Dr. Lawrence H. Snyder, Professor of Zoölogy, Ohio State University, Columbus, Ohio. "Human Inheritance." College Auditorium.

SATURDAY, APRIL 2

8:30—9:30 a. m. Main Academy business session, Science Hall, room 210.

1. Reports of all committees and new business.
2. "The Kansas Academy of Science—Past, Present and Future." W. H. Schoewe, President elect. 15 minutes.
3. Paper demonstration. Drawings and Photographs for Reproduction in our Transactions. W. J. Baumgartner, U. of K. 5 minutes.

9:30—12:00. Section meetings.

The Kansas Entomological Society, room 203, Science Hall.

Science Teachers Program, room 210, Science Hall.

Joint session, Kansas Section of the Mathematics Association of America and Kansas Association of Teachers of Mathematics, Music Hall Auditorium.

American Association of University Professors, room 110, Russ Hall.

12:00—Noon. Luncheon and Social Hour, Mathematics Societies, Cafeteria.

12:30 p. m. Luncheon, University Professors, Hotel Stilwell.

1:30 p. m. Section Programs.

Kansas Association of Teachers of Mathematics, Russ Hall, room 312.

Kansas Section, Mathematics Association of America, Russ Hall, room 323.

American Association of University Professors, room 110, Russ Hall.

PAPERS SUBMITTED FOR THE SIXTY-NINTH ANNUAL MEETINGS

BOTANY

Chairman: MARGARET NEWCOMB

Friday, April 1, 10:00 a. m. to 12:00 noon, Science Hall, Room 203.

1. Botanical Notes for 1937-1938. Frank U. G. Agrelius, K. S. T. C., Emporia.
2. Notable Trees of Kansas-IV. Frank U. G. Agrelius, K. S. T. C., Emporia.
3. An Ecological Study of Wolf's Bog, Michigan. Ruth Dutro and Edith Cohoe, U. of Mich.
4. Woody Plants of Kansas, Native and Naturalized. F. C. Gates, K. S. C.
5. Layering in Black Spruce (*Picea mariana*). F. C. Gates, K. S. C.
6. Kansas Botanical Notes, 1937. F. C. Gates, K. S. C.
7. Studies on *Eryngium yuccifolium*. J. A. Trent, K. S. T. C., Pittsburg.
8. A Fungous Parasite of Spirogyra. Margaret Newcomb, K. S. C.
9. The Bearing of Zalenski's Law on Conifer Leaves. Lucile B. Burt, K. S. C.
10. Kansas Mycological Notes, 1937. C. O. Johnston, T. Brooks, K. S. C.
11. A Curious Dandelion. S. Fred Prince, Galena, Mo. Presented by F. C. Gates.
12. Mycelial Distribution and Internal Pycnia in Systematic Infections of *Uromyces caladii* on *Arisaema triphyllum*. S. M. Pady, Ottawa U.
13. The *Myxomycetes* of Kansas. Travis E. Brooks, K. S. C.

1:00 p. m to 4:30 p. m.

14. Study in Germination of Seeds of *Commelina virginica*. James C. Bates, K. S. C.
15. Some Species of *Taphrina* with Intracellular Habit. A. J. Mix, U. of K.
16. A New Alga in the Scenedesmaceae. R. H. Thompson, U. of K.
17. Further Studies of the Morphology of *Taphrina caerulescens*. Edna Old, U. of K.
18. Cultural Studies of *Sclerotium rolfsii* Sacc. and *Sclerotium delphinii* Welch. D. J. Obee, U. of K.
19. Notes on the Habits and Environment of *Cooperia kansensis*. W. C. Stevens, U. of K.
20. Infection Studies of *Cronartium quercum*. Aeciospores on Seedlings of Pinus spp. L. J. Gier, Campbell College, N. C. Presented by title.
21. Data and Conclusions on the Correct Pruning Methods for Trees in Eastern Kansas. William Donald Durell, U. of K.
22. Cöordination of Leaf Structure with Habitat and Growth Habit in *Viorna pitcheri* and *Viorna fremontii*. Florence E. Dill, U. of K.
23. An Anatomical Study of *Asclepias incarnata*, *A. quadrifolia* and *A. pumila*. M. W. Mayberry, U. of K.
24. Ecological Anatomy of the Leaf of *Oenothera laciniata*. Robert Lommasson, U. of K.
25. Studies in Breaking the Rest Period of Grass Plants by Treatments with Potassium Thiocyanate and in Stimulating Growth with Artificial Light. Harold R. Shepherd, Hays.
26. Prairie Studies in West Central Kansas. F. W. Albertson, Hays.
27. Studies of a 189 Year Old American Elm Tree in West-Central Kansas. F. W. Albertson, Hays.
28. Yeastlike Organisms from the Human Scalp. Clinton C. McDonald, U. of Wichita.
29. Lodging and Crinkling of Wheat Culms. Hurley Fellows and C. H. Ficke, U. S. D. A., Manhattan.

CHEMISTRY

Chairman: LLOYD MCKINLEY

Friday, April 1, 1:00 p. m. to 5:00 p. m., Carney Hall, Room 211

1. Electrodeposition of Tin from Solutions of its Complex Salts. Robert Taft and R. H. Hess, U. of K.
2. Gasoline Antioxygens. Carl W. Berger, McPherson.
3. Some Chemical Factors Involved in Acidation of Oil Wells. Troy J. Stewart, Lloyd McKinley and L. C. Morgan, U. of Wichita.
4. Animal Life in Synthetic Mixtures of Nitrogen and Oxygen with Different Percentages of Relative Humidity. J. Willard Hershey, McPherson College.
5. Controlling the Color of Iron Clays. William K. Zinszer, Tuscaloosa, Ala.

6. Partial Molal Volumes of the Binary Systems: Water-cellosolve and Water-carbitol, Agnes Nibarger and Lloyd McKinley, U. of Wichita.
7. An Illustrated Periodic Chart. Karl S. Bergstresser, Ottawa Univ.
8. The Economy of Water Softening. H. W.. Brubaker, K. S. C.
9. Hydrogen Ion Concentration: Some Uncertainties. Arthur W. Barton, F. H. K. S. C.
10. Papain: A Proteolytic Vegetable Ferment. Arthur W. Barton, Hays.

GEOLOGY

Chairman: J. M. JEWETT

Friday, April 1, 10:00 a. m. to 12:00 noon, Mine Building Lecture Room

1. Fossil Collections in the High School. Homer A. Stephens, Atchison.
2. Cherokee Cyclothems. G. E. Abernathy, Kansas Geological Survey, Lawrence.
3. Metamorphic Effects of the Granite Intrusion in Southern Woodson County. D. C. Schaffner, C. of E., Emporia.
4. Gastroliths of the Lower Dakota in Northern Kansas. D. C. Schaffner, C. of E., Emporia.
5. A Graphic Solution of the True Axil Angle of Biaxial Crystals from Their Indices. J. H. Lane, Jr. and H. T. U. Smith, U. of K.
6. Some Mineralogical Analyses of Sandstones in Eastern Kansas. R. E. Whitla, U. of K.
7. Terrace Sands of Eastern Sedgwick County, Kansas. Louis Michaelson, Univ. of Wichita.
8. Preliminary Reports on the Chert Gravels of the Lower Kansas River Valley. Wm. K. McFarquhar, U. of K.
9. The West Atchison Glacial Section. W. H. Schoewe, U. of K.
10. Celestite, Brown County, Kansas. W. H. Schoewe, U. of K.
11. A Subsurface Study of the Black Shales of Western Kansas. Glen H. Gordon, Wichita.
12. A Sink Hole Near Potwin, Kansas. Glen H. Gordon, Wichita.
13. The Genus *Enteletes* with a Description of a New Species. Arthur Bridwell, Baldwin.
14. A Contrast Between the Sedimentary Rocks of Wisconsin and Kansas. L. C. Wooster, Emporia.
15. The Fossil Beds of Northwest Nebraska as Observed by the McPherson College 1937 Biology Trek. Philip Davis, McPherson College.
16. Foraminifera of the Jetmore Chalk of Kansas. John R. Embrich, Fort Riley.

PHYSICS

Chairman: C. V. KENT

Friday, April 1, 1:00 p. m. to 5:00 p. m., Mechanical Arts Bldg., Room 205

1. Some New Lecture Demonstrations. Louis R. Weber, Friends Univ.
2. Atomic Cross-section Curves for Electrons of Moderate Speeds. J. Howard McMillen, K. S. C.
3. A Magnetic Electron-Microscope. J. Howard McMillen, K. S. C.
4. A Small Improvement on Emberson's Method for Testing Quarter Wave Plates. C. V. Kent, U. of K.
5. The Behavior of Electrets. Wilfred M. Good, U. of K.
6. The Process of Making Optical Mirrors by Evaporation of Metals. Stanley Alexander, U. of K.
7. Solving Problems in the Measurement of Gases. J. A. Brownlee, Wichita.
8. The Mapping of Electric Fields into Curvilinear Squares. Richard J. W. Koopman, U. of K.
9. The Rôle of the Dielectric Constant of an Addition Agent in a Plating Bath. I. Urea and Glycine in Copper Sulfate and Silver Nitrate Baths. Penrose S. Albright and Carl E. Gordon, Southwestern College.
10. The Rôle of the Dielectric Constant of an Addition Agent in a Plating Bath. II. Glycine in a Gold Chloride Bath (Preliminary). Penrose S. Albright and Arthur L. Stauffacher, Southwestern College.
11. The Rôle of the Dielectric Constant of an Addition Agent in a Plating Bath. III. Alpha Amino Butyric Acid in a Copper Sulfate Bath (Preliminary). Penrose S. Albright and Harlan E. Lenander, Southwestern College.
12. Pressure Effects with Respect to Absorption and Optical Activity, by Richard H. Zinszer, Union Oil Co., Wilmington, California.

PSYCHOLOGY

Chairman: O. W. Alm

Friday, April 1, 10:00 a. m. to 12:00 noon, Room 315, Russ Hall

1. Reading Training for College Freshmen. V. T. Smith, Kansas Wesleyan University.
2. The Development of a Personality Scale. A. L. Hunsicker, U. of K.
3. The Influence of Separate Answer Sheets on the Reliability and Forms of Standardized Achievement Tests. James E. Kuntz, F. H. K. S. C.
4. Some Behavior Variables in Relation to Climatic Cycles. R. H. Wheeler, U. of K.
5. Height Weight Studies of 97 High School Students, Protection, Kansas. L. J. Gier, Campbell College, N. Carolina. Read by title.

1:00 p. m to 4:00 p. m.

6. Talk (Subject to be Announced). Jacob Uhrich, K. S. T. C., Pittsburg.
7. Influence of the Home on Young Children. D. A. Worcester, U. of Nebraska.
8. Achievement in High School of Graduates from Graded and Ungraded Elementary Schools. H. B. Reed, F. H. K. S. C.
9. The "Six Problem." Robert L. Brigden, Wichita Child Research Lab.
10. Psychological Diagnoses and Their Importance in a Community Program for Child Welfare. Edra Weathers, Wichita Child Research Lab.
11. An Evaluation of Beck's Rorschach Norms as Applied to Children. Leone Jacobson, Wichita Child Research Lab.
12. The Phenomenon of Mother Fixation as An Expression of the Child's Doubt of the Parent's Affection. Edwina A. Cowan, Wichita Child Research Lab.
13. 1,000 Consecutive Cases of Speech Defects. Martin F. Palmer and Courtney D. Osborn, U. of Wichita.
14. Insulin Shock Therapy in the Psychoses. Ralph L. Drake, Wichita Child Research Lab Moving Picture.
15. Brain Function in Audition. L. A. Bennington, U. of Ark., Fayetteville.
16. The Possibility of an Experimental Approach to Robinson's Association Theory Today. R. H. Waters, U. of Ark., Fayetteville.
17. An Interesting Case of Brachydactily Combined with Polydactily. D. C. Schaffner and R. E. Bugbee, Emporia, Kansas.

ZOÖLOGY

Chairman: Claude Hibbard. Chm. pro tem C. E. Burt

Friday, April 1, 10:00 a. m to 12:00 noon, Science Hall, Room 211

1. Parasite Emergence Holes as a Criterion of Infestation in Mature Wheat Plants. Elmer T. Jones, Manhattan.
2. Transmission of Poultry Parasites by Birds, with Special Reference to the "English" or House Sparrow, and Chickens. W. L. Hoyle, Bavaria.
3. The Frogs and Toads of the Southeastern United States. Charles E. Burt, Southwestern College.
4. On Mexican Toads of the Genus Hypopachus. Edward H. Taylor, U. of K.
5. Some Additional Data on Climatic and Cultural Cycles. R. H. Wheeler, U. of K.
6. Studies on Nematode Culture. Arlie Todd and J. E. Ackert, K. S. C.
7. The Behavior of the Blood Cells (?) of the Cockroach, *Periplanata americana.* W. J. Baumgartner, U. of K. Moving pictures.
8. A Preliminary Report on the Insects which Feed on Bindweed. Roger C. Smith, K. S. C.
9. An Attempt at an Ecological Evaluation of Predators on a Mixed-prairie Area. L. D. Wooster, F. H. K. S. C.
10. Social Organizations in Albino Mice. Jacob Uhrich, K. S. T. C., Pittsburg.
11. The Microscopic Fauna of Cow Creek, Crawford County, Kansas. Harry H. Hall, K. S. T. C., Pittsburg.
12. Herpetological novelties from Mexico. Edward H. Taylor, U. of K.

1:00 p. m. to 4:40 p. m.

13. The Bones of *Plioambystoma kansensis* (Adams) Compared Historically with the Bones of Recent Ambystoma. Claude Leist, U. of K.
14. A Peculiar Case of Pseudohermaphroditism. S. L. Loewen and L. Odus Rupe, Sterling College.
15. Concerning the Postnatal Obliteration of the Umbilical Vein and Arteries, the Vitelline Vein and Artery, and the Ductus Arteriosus in the Guinea Pig. Mary T. Harman and James E. Herbertson, K. S. C.

16. Effects of X Ray on the Snowy Tree Cricket (*Oecanthus nigricornis argentinus*). Edith Beach, U. of K. Read by title.
17. Effects of Nicotine upon Albino Rats. Hazel E. Branch and W. Glen Moss. U. of Wichita.
18. Wing and Pronotum Length of Tettigidea (Grouse locust). R. K. Nabours and Nelle MacQueen Morgan, K. S. C.
19. The Effect of Anterior Pituitary and Anterior Pituitary-like Hormones on the Gonads of Fowls. Charles Lockhart, Thomas Groody, and E. H. Herrick, K. S. C.
20. The Effect of Male Hormone on the Developing Ovaries of Fowls. E. H. Herrick and Charles Lockhart, K. S. C.
21. The Thyroid Glands of Fowls after Adrenalectomy. Jack Finerty and E. H. Herrick, K. S. C.
22. A Review of Kansas Ichthyology. John Breukelman, K. S. T. C., Emporia.
23. Riboflavin (Vitamin G) Content of Milk as Influenced by Stage of Lactation. Bernice L. Kunerth and W. H. Riddell, K. S. C.
24. Observations on the Ovaries of Guinea Pigs Receiving a Vitamin C-deficient Diet. O. B. Saffry, M. M. Kramer, M. T. Harman and H. D. Kirgis, K. S. C.
26. Susceptibility of Adult Chickens to Tapeworm Infestations. Arthur A. Case and J. E. Ackert, K. S. C.
27. Worms in Hen's Eggs. J. E. Ackert, K. S. C.
28. Comparative Histology and Resistance to Parasitism. Allen Edgar and J. E. Ackert, K. S. C.

JUNIOR ACADEMY OF SCIENCE

President: OSCAR KLINGMAN, Junction City Science Club

Friday, April 1, 2 p. m., Mechanic Arts Building, Physics Classroom

1. Introduction Service for new clubs:
   - High School Science Club, Bavaria. Sponsor, W. L. Hoyle.
   - High School Science Club, Columbus. Sponsor, Kenneth McClure.
   - High School Science Club, Fort Scott. Sponsor, Ross Anderson.
   - High School Science Club, Galena. Sponsor, Robert Troughton.
   - Arkansas City Science Club, Arkansas City. Sponsor, C. E. Ruff.
   - General Science Club, Independence. Sponsor, P. W. Dennis.
   - Junior High Science Club, Iola. Sponsor, Seth J. Owens.
   - S. O. S. Science Club, Lakeside Jr. High School, Pittsburg. Sponsor, J. Frank Hopkins.
   - P. H. S. Science Club, Pittsburg Senior High School. Sponsors, Claude I. Huffman, Dora M. Peterson and Charles Thiebaud.
2. Group demonstrations:
   - Chemistry Club, Wichita High School East. J. A. Brownlee, Sponsor.
   - S. O. S. Science Club, Lakeside Jr. High School, Pittsburg.
   - High School Science Club, Columbus.
   - P. H. S. Science Club, Pittsburg.
3. Individual papers, reports, demonstrations, etc.
   - General Science Club, Independence.
     - Anthropometrics. E. R. Stevens, Jr.
     - Volcanic Products. Paul Dillman.
     - Alkaloids. F. C. Furnas, Jr.
   - Nature Study Club, Lawrence Jr. High School.
     - Rocket Ships. Robert Bayles.
     - Effects of Feeding Experiments on White Rats. Joanna Wagstaff.
4. Doing the Impossible. Louis R. Weber, Friends Univ.

KANSAS ENTOMOLOGICAL SOCIETY

FOURTEENTH ANNUAL MEETING

SATURDAY, APRIL 2

Pres., WARREN KNAUS, deceased; Vice-pres., L. C. WOODRUFF; Secretary-treasurer, H. H. WALKDEN, Science Hall, Room 203

BUSINESS MEETING .... 9:30-10:30 a. m

PRESENTATION OF PAPERS .... 10:30 a. m.

1. The Identification of Burrowing Insects by Their Burrow Characteristics. Harry R. Bryson, K. S. C.
2. Observations on the Ecology of the Corn Seed Beetle (*Agonoderus pallipes*, Fab.). Franklin Dillon, K. S. C.
3. Some Notes on the Family Belostomatidae of the Western Hemisphere. D. Warren Craik, U. of K.
4. Report on Some New Species of Water Bugs. H. B. Hungerford, U. of K.
5. Variation in *Habrodais grunus* (Boisd). Lepidoptera: Lycaenidae.
6. Some Notes on Curculionidae, Lyman S. Henderson, U. of K.
7. The Oviposition of Corixids upon Crayfish. Melvin E. Griffith, U. of K.

1:00 p. m.

8. Corixid Eggs as Human Food in Mexico. H. D. Thomas, U. of K. Motion picture.
9. Possible Physiological Factors in the Distribution of Notonecta in Mexico. H. D. Thomas, U. of K.
10. Observations on the 1937 Grasshopper Survey. Roland W. Portman, K. S. C.
11. The Internal Sac of the Male Genitalia as Taxonomic Character in Phyllophaga. Milton W. Sanderson, U. of Ark., Fayetteville.
12. Some Entomological Observations Made During Termite Inspections. C. R. Rogers, Wichita.
13. Chrysopidae Seen in European Museums. R. C. Smith, K. S. C.
14. Fluctuation in the Grasshopper Population in Grass Lands During the Drought Years, 1933-1937. Donald A. Wilbur and Roy Fritz, K. S. C.
15. Parasites Reared from the Strawberry Leafroller (*Ancylis comptana* Froel). Ralph L. Parker and Paul G. Lamerson, Kan. Agr. Exp. Sta.
16. Preliminary Report on Distance, as the Isolating Factor in Three Species of Eurytomidae. Robert E. Bugbee, College of Emporia, Emporia, Kan.

SCIENCE TEACHERS PROGRAM

Chairman: DR. W. J. BAUMGARTNER

Saturday, April 2, 9:30 a. m to 12:00 noon, Science Hall, Room 210

1. Oxidation and Reduction as a Means of Measuring Intelligence and Activity in Students Taking Beginning Chemistry. Lawrence Oncley, Southwestern College.
2. The Teaching of General Science. Edith Beach, U. of K.
3. Report of a Study of What Should Be the Content of a High School Course in Biology. C. E. Ruff. Arkansas City High School.
4. The Problem Approach to the Teaching of Biology. R. Will Burnett.
5. New Apparatus for Experiment 14 in the Laboratory Manual by Bruce, and the Construction of a Drop-stopper. J. A. Brownlee, Wichita.
6. Is There a Place for a National Association of Biology Teachers? O. P. Dellinger, K. S. T. C., Pittsburg.
7. The Third Dimension in the Teaching of Biology. Sister M. Anthony Payne, Mount St. Scholastica College.
8. Making Moving Pictures for Teaching Chemistry by Students in High School or as a Club Project. J. A. Brownlee, Wichita.

TWENTY-FOURTH ANNUAL MEETING KANSAS SECTION, MATHEMATICS ASSOCIATION OF AMERICA, and THIRTY-FOURTH ANNUAL MEETING KANSAS ASSOCIATION OF TEACHERS OF MATHEMATICS

Presiding Officer: C. B. Tucker

Joint Session, Saturday, April 2, Music Hall Auditorium, 9:30 a. m. to 12:00 noon.

1. Address of Welcome.
2. Response—Minnie Stewart, Topeka High School.
3. Mathematical Requirements for High School Graduation and College Entrance. A. R. Congdon, U. of Nebraska, Lincoln.
4. Scientific Surplus. R. W. Babcock, K. S. C.
5. Report on the National Commission on the Place of Mathematics in Secondary Education. U. G. Mitchell, U. of K.
6. Business Meeting.

Noon: Luncheon and Social Hour, Cafeteria.

K. A. T. M. SESSION

Presiding Officer: Anna Marm

Russ Hall, Room 312, 1:30 p. m.

1. Mathematics in Progressive Education Experiment, Mary C. Young, Sunset High School, Kansas City, Mo.
2. Bridging the Gap Between High School Mathematics and College Mathematics. A. R. Congdon, guest speaker, U. of Nebr., Lincoln.

M. A. A. SESSION

Presiding Officer: C. B. Tucker

1:30 p. m.

1. On Bernoulli Polynomials and Numbers. G. C. Munro, K. S. C.
2. Vexing Minor Problems of the Mathematics Curriculum. C. B. Read, U. of Wichita.
3. The Pascal Configuration in a Modular Geometry. C. Rickart, U. of K.
4. A Program for the Association. G. B. Price, U. of K.
5. Election of Officers.

OFFICERS—K. S. M. A. A.

Chairman, W. G. Warnock, Hays; vice-chairman, C. B. Tucker, Emporia; secretary-treasurer, Lucy T. Dougherty, Kansas City; nominating committee, Emma Hyde, Manhattan; J. J. Wheeler, Lawrence and R. G. Smith, Pittsburg.

OFFICERS—K. A. T. M.

President, Anna Marm, Lindsborg; vice-president, Minnie Stewart, Topeka; secretary-treasurer, Helen R. Garman, Emporia; editor of the Bulletin, Ina E. Holroyd, Manhattan.

NEBRASKA AND KANSAS CHAPTERS AMERICAN ASSOCIATION OF UNIVERSITY PROFESSORS

Dr. D. A. Worcester, Regional Chairman

Dean C. M. Correll, Kansas State College, presiding

Meeting for Kansas and Nebraska

Saturday, April 2, 1938, 10:00 a. m. to 12:00 noon, Russ Hall, Room 110

1. Greetings from President W. A. Brandenburg, Kansas State Teachers College, Pittsburg.
2. The Responsibility of the Individual Faculty Member in Respect to Institutional Relationships. Dr. D. A. Worcester, University of Nebraska.
3. Retirement Annuities. Dr. Hugo Wall, University of Wichita.
4. Faculty Participation in Administrative Activities. General discussion.

LUNCHEON—12:30, Hotel Stilwell

Dr. C. W. Street, Kansas State Teachers College, Pittsburg, presiding

1. Faculty Responsibility for Student Opinion. Charles F. Scott, E. M. Doan.
2. Aims and Objectives of the Local Chapter. Professor C. E. Rogers, Kansas State College.
3. Professional Ethics. Dr. John Rydjord, University of Wichita.

MINUTES AND REPORT OF THE SEVENTIETH ANNUAL MEETING

The first session of the seventieth annual meeting of the Kansas Academy of Science was called to order by Geo. A. Dean, the president, at 8:30 a.m. March 31, 1938, in the auditorium of the Horace Mann school, Pittsburg, Kan. The president appointed the following committees: Resolutions, Mary T. Harman, R. E. Mohler, Paul Murphy; Auditing, Geo. Kelly, Arthur Swanson, Claude Leist; Nominations, Lawrence Oncley, J. E. Ackert, O. P. Dellinger. The reports of the secretary and treasurer were read and accepted. L. D. Wooster moved on behalf of the nominating committee that the Academy contribute $100 from the treasury for research awards. The motion was passed. President-elect Schoewe spoke briefly of plans for the coming year and announced the personnel of the standing committees for the next year.

After a series of general announcements the business meeting adjourned. There was no general program at the meeting, but the time, except for the two business meetings, was fully allotted to section meetings. On Friday morning the following sections met: Botany, with 28 papers and an attendance of 50; Geology, meeting for the first time as a section, with 16 papers and an attendance of 47; Psychology, 17 papers and an attendance of 75; and Zoölogy, with 29 papers and an attendance of 75. In the afternoon of April 1, the sections on Botany and Zoölogy were continued while the geologists took a trip to the coal strip mines of the region. The sections on Physics, with 11 papers and an attendance of 55, and Chemistry, with 10 papers and an attendance of 60, were concluded.

The senior and junior banquets were held Friday evening at the college cafeteria, with an attendance of 180 at the senior banquet and 125 at the Junior Academy banquet. Dr. W. H. Schoewe, president-elect, served as toastmaster. President W. A. Brandenburg, of the college, responded with an address of welcome to the two groups. Prof. Geo. A. Dean gave the president's address on the subject "The Contributions from Kansas to the Science of Entomology." The group then adjourned to the college auditorium to hear the annual invitation address, given this year by Dr. Lawrence H. Snyder, professor of zoölogy, Ohio State University, on the subject of "Heredity and Human Affairs," before an audience of approximately 500.

On Saturday morning, April 2, the Academy again met in a business session for the hearing of reports of committees and new business. The fourteen committees gave oral or printed reports, all of which were accepted. The reports are printed here immediately following this report.

The following recommendations of the Executive Council were adopted by the Academy: (1) $500 be transferred from the general fund to the endowment fund of the Academy. (2) That half of expense of the secretary for attending the A. A. A. S. meeting at Indianapolis as Academy representative, or $24.15, be allowed. (3) That H. A. Zinszer, the treasurer, be the Academy representative at the Richmond, Va., meeting and that his railroad fare be paid by the Academy in recognition of his six years' efficient work as Academy treasurer. (4) That the Academy purchase a loving cup for the Junior Academy section, that the names of the winning group be engraved on it each year and when

won by one group three times that it become the property of that group; that the Academy purchase silver and bronze medals to be awarded to the first and second individuals selected by the judges of the Junior Academy individual demonstrations, and that the Junior Academy Committee be authorized to buy the cup and medals. (5) That members be informed of the availability of reprints of "Instructions to Authors" and that it be sent when requested. (6) That enough associate editors be selected to provide one in each subject represented by Academy sections. (7) That 400 reprints of papers published in the TRANSACTIONS be furnished authors without any charge whatsoever except in case of an abnormal number of plates and that there be no variation from the number 400. (8) That the library exchange value of the TRANSACTIONS be declared to be $3, inasmuch as the dollar annual dues does not include any part of the actual cost of the TRANSACTIONS; that the TRANSACTIONS be not sold by the Academy except where back volumes cannot be supplied by sale or exchange by any of the three coöperating libraries. (9) That the editorial board gather information looking to the renewal of the contracts of the three coöperating libraries when the present contracts expire. (10) And that Miss Margaret Newcomb be appointed official representative of the Academy to the 500-year celebration of the University of Köln, Germany, June 24 to 26, 1938.

Doctor Schoewe presented the following three amendments to the constitution and bylaws, to be acted upon at the next meeting.

PROPOSED AMENDMENTS

Amendment to Constitution. Sec. 3, Art. 2:

"Any person who shall have paid thirty dollars in annual dues or equivalent due to legal exemption, or in one sum, or in any combination, may be elected to life membership, free of assessment, *by a two-thirds vote of the members present at an annual meeting.*" Change underscored to read:

"Upon recommendation by the Membership Committee and a majority vote of those attending the annual business meeting of the Academy."

Amendment to Constitution. Sec. 3, Art. 3:

"Honorary members may be elected because of special prominence in science upon written recommendation of two members of the Academy, by a two-thirds vote of the members present. Honorary members pay no dues." Change to read:

"Honorary members may be elected because of special prominence in science by being nominated by at least two Academy members in good standing, the nomination being submitted in writing to the Membership Committee for approval and recommendation to the Academy at its annual meeting. A two-thirds vote of all members present at the annual business meeting shall constitute election. Honorary members pay no dues."

Amendment to Bylaws. Article II.

The president shall deliver a public address *on the evening of one of the days* of the meeting, at the expiration of his term of office. Change to read:

"The president shall deliver a public address *at one of the general sessions* of the meeting."

Dr. Hazel Branch presented an invitation for the Academy to meet at Wichita in 1940. The invitation was referred to the Executive Council.

Following adjournment of the business meeting the following sections and coöperating societies met: The Kansas Entomological Society, an affiliated

society, with 17 papers and an attendance of 35; Science Teachers, a new section, with 9 papers and an attendance of 150; two coöperating mathematical societies —the Kansas section of the Mathematics Association of America with 5 addresses and an attendance of 50, and the Kansas Association of Teachers of Mathematics with 2 addresses and an attendance of 50, but meeting in a joint session Saturday morning to hear 5 addresses; the Nebraska and Kansas chapters of the American Association of University Professors meeting in both morning and afternoon sessions to hear 7 addresses, with an attendance of 45.

The Executive Council, at the usual noon meeting, passed for recommendation to the Academy the following motions: (1) That Doctor Schoewe's paper on "The Kansas Academy of Science—Past, Present and Future" be recommended as suitable for presentation at the Academy Conference, Richmond, Va., meeting of the A. A. A. S., and that half of his railroad fare to the meeting be paid by the Academy. (2) That the secretary be authorized to hire a full-time stenographer prior to the annual meeting and immediately following, to take care of the preparations for the meeting and the business immediately following. (3) That the stenographer in the Botany Dept., K. S. C., be paid $20 for extra and overtime work during the last seven years. (4) That members of the Executive Council, in view of the large amount of work done by the council, be reimbursed for attending the Pittsburg meeting to the extent of a round-trip railroad fare. (5) That the Kansas Academy look with disfavor upon the suggestion of meeting with the Missouri Academy of Science at Kansas City in 1940 or soon thereafter. (6) That a "Science Week" be held occasionally in Kansas, during which the various scientific organizations of the state may meet. (7) That a resolution be drawn up and sent to the proper authorities favoring the location of one of the four laboratories for chemical investigations of farm wastes and surpluses be located in Kansas. (8) And that a resolution be sent to the permanent secretary of the A. A. A. S., urging that the association meet in Kansas City in 1940 or 1942.

Two hundred thirty-six members registered at the meeting and were given badges, while the attendance at the two business meetings was 60 and 70. The Kansas State Teachers College were excellent hosts. Buses were at the disposal of groups for trips to the mines and other points of interest in the region. The College and local committee bore the entire expense of the meeting. Prof. Ernest Bennett, professor of journalism, K. S. T. C., Pittsburg, was placed in charge of newspaper publicity, with excellent accomplishments. Arrangements for the meeting were ample and well planned in advance of the meeting. Other features which made the meeting one of the best in recent years was the splendid showing of the Junior Academy and the largest list of new members for any year in the history of the Academy. One hundred eighty members were added to the roll during the year.

The various sections reported election of the following chairmen for 1939:

Botany: C. C. McDonald, Wichita.
Chemistry: Fayette T. Owen, Emporia.
Entomology: L. C. Woodruff, Lawrence.
Geology: D. C. Schaffner, Emporia.
Junior Academy: Bill Okey, Pittsburg.
Physics: Penrose S. Albright, Winfield.
Psychology: Joseph W. Nagee, Emporia.
Science Teachers, Biology: Lorene Bailey, Parsons.
Science Teachers, Physical Science: Lawrence Oncley, Winfield.
Zoölogy: Earl Herrick, Manhattan.

The nominating committee presented its report, which was accepted unanimously. The new officers assumed their duties at the close of the Saturday morning business meeting. Respectfully submitted,

ROGER C. SMITH, *Secretary*.

April 4, 1938. GEO. A. DEAN, *President*.

REPORT OF THE SECRETARY, MARCH 10, 1938

The minutes of the sixty-ninth meeting, Manhattan, April 1-3, 1937, were prepared and have been printed in volume 40 of the TRANSACTIONS. The report for "Science" was printed in volume 85 (2213): 551-523, 1937.

One thousand five hundred letter heads, 1,000 envelopes and 600 four-page announcements of research grants and officers for 1937-'38 were ordered on April 17. The awards were announced June 25 and checks distributed on July 3.

The academy membership fee of $5 to the Commission on the Preservation of Natural Conditions in the U. S. Ecological Society of America was paid April 26.

The exchange lists of the three coöperating libraries were obtained and put in form for publication in volume 40.

Traded in the old addressograph on a new one on May 10, the net cost being $84.80, which included a set of new stencils typed from the latest membership list.

The issue of volume 39 of the TRANSACTIONS was received July 15, 1937, and distributed at once to all members whose dues were paid for 1936. Reprints were distributed at the same time and bills for the author's share of office expenses in publishing their papers ranging from 50 cents to $1.50 for each paper were mailed July 29.

Bought stamps to the amount of $76.56, which was the balance of the $300 state illustrations fund. The halftones and etchings for volume 40 cost $244.44, which amount was paid September 27.

The next meeting dates were set for the Pittsburg meeting on November 12, and 600 tan dues cards were ordered for the 1938 dues.

The secretary, accompanied by Messers Hall, Gates, Wells, and Baumgartner, represented the academy at the Academy Conference, Indianapolis, December 27. Doctor Baumgartner and the secretary took part in the discussion.

Ordered 800 copies of the eight-page announcement of the Pittsburg meeting on January 19 and sent them to the membership. The response to dues notices and of nominations of new members was excellent, but titles came in slowly. Chairmen of sections were asked to contact their groups on February 15. The response at the end of the month was splendid.

A map of the Pittsburg region was ordered for the program February 24, at a cost of $4.87. Three hundred badges were ordered March 5, at a cost of $16.32; 1,500 programs were ordered from Kimball Printing Co., on March 12, at a cost of $45.

The secretary was notified November 12 that the A. A. A. S. research allotment for 1938 would be $75. It was hoped that the increase in membership would entitle us to $100. This fund is a refund of fifty cents per Academy

member who are also members of the A. A. A. S. If 25 members would join the American Association our award would be increased to $100.

Arrangements were made with the University Professors and the two Mathematics Associations to hold their meetings in conjunction with the Academy meetings, and their programs were included in the Academy program.

The following is a summary of the membership on March 10, 1938:

Honorary members	8
Life members	48
New annual members since April 1, 1937 (including 11 new Junior Academy Clubs)	189
Annual members paid up for 1938	296
Annual members paid up for 1937, not 1938	194
Annual members not paid for either 1937 or 1938 (to be dropped from next membership list)	79
Total members on the roll	725

Last Year's report: New Members, 104; 476 annual members including 6 Junior Academy Clubs, Life members, 49; honorary members, 10.

Lists of nominations of new members were sent to the membership committee as follows: November 12, thirty-four names; February 14, twenty-eight names; and there is a final accumulation of fifty-six names to be submitted soon. All persons and Junior Academy groups nominated were approved by the membership committee. A meeting announcement, a letter of notification and information and a membership card was sent to all new members following their election.

Committee allotments for expenses were made by the executive committee as follows: $50 to the Committee on Natural Areas and Ecology; $25 to the Committee on Educational trends; and $25 to the Junior Academy Committee.

Miss Frances Cole, N. Y. A. student at Kansas State College, served most capably as stenographic assistant to the secretary during the school year 1937-1938.

The following members resigned during the year: Ivan Pratt, David Beaudry (previously dropped), Wayne E. White, Hjalmar E. Carlson, and Selma Gottlieb Kallis (had been dropped). Four members died during the year.

REPORT OF THE MEMBERSHIP COMMITTEE

The following new members have been accepted by the membership committee between April 3, 1937, and April 20, 1938:

Abilene: Seward E. Horner.
Arkansas City: Science Club.
Atchison: Margaret Mayerus, Mary C. Kilkenny, Cecila Burke, Theodore F. Andrews.
Baldwin: Richard R. March.
Bavaria: H. S. Science Club.
Bethel: Glen Fuller.
Bison: Robert D. Lippert.
Cambridge, Mass.: Library Mass. Institute of Technology.
Cedarvale: Frank L. Stark.
Cherryvale: Jr. Science Club.
Chicago, Ill.: Miss June White.
Columbus: H. S. Science Club.
Coats: Lester R. Branson.
Conception, Mo.: Lauranne Brady.
Concordia: R. W. Burnett.
Detroit, Mich.: Edith Cohoe.
Dodge City: Marvin E. Rolfs, J. D. Schwartz.
Douglass: James T. Newton.
East St. Louis, Ill.: Anna J. Reardon.
Emporia: Edward Jesse Calkins, Charles B. Tucker, Robt. E. Bugbee, C. F. Gladfelter, Richard A. Goff, Gene K. Lockhard, Robert Myers, Chas. L. Smith, Conrad Vandervelde, Glenn Harvey Love, Theodore Andrews.
Erie: Wendell L. Johnson.
Eureka: Gail M. Breithaupt.
Fayetteville, Ark.: General Library.
Fort Riley: Maj. John R. Embrich.
Fort Scott: H. S. Science Club, M. W. Allen, Bess McWilliams, F. C. Stockebrand, Jack DeWitt.
Fort Smith, Ark.: Germaine Rachaner.
Galena: High School Science Club.
Galena, Mo.: S. Fred Prince.
Hagerstown, Ind.: Ruth Dutro.
Hays: Lael O. Gilbert, Jas. E. Kuntz, James Brazil, Maurice Albertson, Harold R. Shepherd, Jas. H. D. Teller, George L. Thomas, Wm. K. Zinszer.
Herndon: Catherine Weishapl.

Hesston: D. D. Driver.
Independence: General Science Club, Elmer L. Banion.
Iola: Jr. H. S. Club.
Kackley: Harold Edberg.
Kansas City, Kan.: F. S. Hoover, Albert Emery, Mary Ellen Parker.
Kingman: Charles E. Ruff, Allen H. Shaffer.
Langdon: Clare H. Royce.
Lawrence: Chester B. Cunningham, H. H. Lane, Richard Koopman, Max D. Wheatley, Florence E. Dill, Bruce F. Latta, Raymond Whitla, Jas. W. Sprague, Robt. C. Lommasson, Wilfred Good, Wm. Donald Durell, Robt. H. Hess, John W. Enders, Bert Pinner, Luke H. Ponder, Lyman Terry, Wayne E. White.
Leavenworth: Lillian J. Proietto.
Lindsborg: Kenneth Frain, Wendell L. Holt, Carl E. Johnson, Joe L. Hermanson, Lillian C. Thomsen, Kenneth L. Johnson.
Lyons: John W. Enders.
Manhattan: Harry H. Smith, H. H. Walkden, Marion C. West, Franklin Dillon, Jack Finerty, C. H. Ficke, J. Howard McMillen, Roland Portman, J. B. Tuck, Manhattan H. S. Science Club, Arlie Todd, Allen Edgar, Arthur Case, Chas. H. Lockhart, Hurley Fellows, Roy C. Langford, Roy F. Fritz, A. B. Cardwell, Hazel M. Fletcher, A. D. Weber, Wong Wai-Sing, Philip Walters, W. H. Riddell.
McPherson: Carl W. Berger, C. E. Wagoner, Phil B. Davis, Robt. E. Mohler, E. H. Dresher, Emerson Yoder.
Mound City: Don Gooden, Blendena Potter.
Ottawa: Paul B. Allen, Arthur Bernhart.
Oxford: Vernon L. Carter.
Parsons: Nila Allen Sewell, Pauline Keller.
Pittsburg: Geo. E. Abernathy, Edw. W. Graham, Leonard R. Provorse, Jacob Ulrich, S. O. S. Science Club, O. W. Chapman, H. S. Jr. Acad. Club, Ross Bennington, L. C. Heckert, E. W. Jones, Marion Whitney, Otta A. Hankammer, R. L. Schwanzle, M. Coventry, F. H. Dickinson, Eugene C. Roberts, Joseph Paul, Laurence Parker, C. W. Street, E. Louise Gibson, Lillian D. Francis. Dr. W. T. Bawden, Josephine A. Marshall, W. E. Matter, R. G. Smith, Mabel O. Bottenfield, Jane M. Carroll, Irene W. Dunbar, L. A. Gutheridge, Genevieve Jordan, Mellicent McNeil, Lillian Schmidt.
Salina: Sister Marie Regina Dickman, Ben Osborn, V. T. Smith, Raymond Litwiller, Carey M. Jensen, Kan. Wesleyan Library.
Sterling: Arthur W. Calhoun, Odus L. Rupe.
Storrs, Conn.: Library Connecticut State College.
Topeka: Steve Smith, Stanley Alexander, Lloyd M. Blanchard, Willard O. Hilton, Ogden S. Jones.
Washington, D. C.: F. M. Wadley.
Wichita: W. Glen Moss, Louis Michaelson, Glen H. Gordon, Leone Jacobson, Orlando Tusler, Ralph L. Drake, Agnes Nibarger, L. C. Morgan, Courtney D. Osborn, Troy J. Stewart, Wichita E. High Chem. Club, Reginald Knowlton, P. D. Schultz.
Winfield: Carl E. Gordon, W. B. Plum.

Total, 189.

Roger C. Smith, F. U. G. Agrelius, Hazel Branch, Mary Larson, Paul Murphy, F. W. Albertson,
Committee on Membership.

REPORT OF TREASURER

April 1, 1937 to March 31, 1938

Receipts

Balance in checking account, April 1, 1937	$111.77
Dues from members	455.00
Reprints to members	35.62
Sale of Transactions	18.59
Exchange rights	600.00
Interest on endowment fund	74.91
A. A. A. S. award	75.00
Principal and interest on postal savings certificates	608.50
Contribution toward program—University professors	3.75
Refund on U. S. Treasury bond	6.28
Appropriation by Kansas legislature	300.00
Total	$2,289.42

Disbursements

Awards:		
R. E. Mohler (A. A. A. S.)	$25.00	
H. D. Kirgis (A. A. A. S.)	15.00	
Noblesse DeMoss (A. A. A. S.)	35.00	
Hazel Branch (Academy)	25.00	
Grace Keroher (Reagan)	32.50	
Total		$132.50
Committee on Junior Academy		24.59
Committee on Conservation and Ecology		42.80
Committee on Science Education Trends in Sec. Schools		19.25
Committee on Coördination of Science Groups		9.98

Secretary:		
Office help	$84.87	
Supplies	58.64	
Stamps and expressage	120.14	
Total		$213.65
Treasurer: Lockbox, bonding, stamps		19.18
Managing editor: Topeka		21.14
Ecological Society: 1937 dues		5.00
Capper Engraving: Cuts		229.31
Kimball Printing: Printing		123.01
Postal savings certificates		500.00
U. S. Treasury bonds: 46567H & 88419K		615.30
Manhattan meeting: Expenses		19.03
Addressograph		73.30
Knauss funeral		1.00
Secretary to Indianapolis: A. A. A. S.		24.15
Balance in checking account		216.23
Total		$2,289.42
Supplementary statement:		
Bank balance	$308.19	
Postal savings certificates	400.00	
2⅞ percent U. S. Treasury bond, 46567H	500.00	
Total		$1,208.19
Uncanceled checks	$91.96	
Payable to endowment fund	2.54	
Total		$94.50
Net balance		$1,113.69

HARVEY A. ZINSZER, *Treasurer.*

REPORT OF ENDOWMENT COMMITTEE

RECEIPTS

Balance in General Fund	$65.43
Cash earnings during 1937	74.91
Total	$140.34

DISBURSEMENTS

Grace Keroher: Reagan award	$32.50
2⅞% U. S. treasury bond 88419K	105.30
General Fund	2.54
Total	$140.34

INVESTMENTS

4 Shares (620 to 623), Morris Plan, Wichita, 5%	400.00
5 Shares (OS-1181), First Federal Savings and Loan of Kansas City, $94.53 at 4%; Certificate No. 1269 Western Shares, $205.47	300.00
1½ Shares (2398 full-paid) Greene County Building and Loan, 4%	150.00
1½ Shares (2679 Class B) Greene County Building and Loan	150.00
1 (11359K) U. S. Treasury bond 1951-'55, 3%	100.00
1 (670L) U. S. Treasury bond 1951-'55, 3%	50.00
1 (L235510) $50 U. S. savings bond, 1945	37.50
1 (C260992) $100 U. S. savings bond, 1945	75.00
1 (D84554) $500 U. S. savings bond, 1945	375.00
1 (C446471) $100 U. S. savings bond, 1945	75.00
1 (C446472) $100 U. S. savings bond, 1945	75.00
1 (D138039B) $500 U. S. savings bond, 1946	375.00
1 (C492889B) $100 U. S. savings bond, 1946	75.00
1 (C492890B) $100 U. S. savings bond, 1946	75.00
1 (C492891B) $100 U. S. savings bond, 1946	75.00
1 (88419K) U. S. Treasury bond 1955-'60, 2⅞%	100.00
1 (233478C) $1,000 U. S. Treasury bond, 1933-'44, 3¼%	1,000.00
In general fund	2.54
Total	$3,490.04

Fifty percent of the Greene county investment is still nonproductive, while 67½ percent of the old Western Savings and Loan (now Western Shares) is also nonproductive. With the exception of the Reagan gift, the endowment fund was increased during 1937 by merely $37.11 while that of the general fund was increased by $567.35. Hence it is recommended that the $500 U. S. Treasurer's bond 46567H be transferred to the endowment fund. All evaluations above are based on purchase value, not the accrued value.

Respectfully submitted,

ZINSZER, GRIMES, ALBRIGHT and HARNLY.

REPORT OF THE AUDITING COMMITTEE

The President, The Kansas Academy of Science: April 1, 1938.

The treasurer's books have been audited as of this date and found to be correct.

The third member of the committee, A. F. Swanson, because of absence from the final committee meeting, has signed a partial report covering the audit of securities. Respectfully submitted,

THE AUDITING COMMITTEE,
GEORGE A. KELLY, *Chairman.*
CLAUDE LEIST.

REPORT OF THE DELEGATE TO THE ACADEMY CONFERENCE INDIANAPOLIS, IND.

Claypool Hotel, December 27, 1937

The program of the Academy Conference consisted of two talks on the place of the Academies in the states, one on the Academy Conference and two on research awards. Mimeographed reports of the research awards made from 1935 to 1937 by the various Academies, were distributed.

In addition to the secretary, H. H. Hall, W. J. Baumgartner, J. R. Wells and F. C. Gates also attended the meeting. The excellent exhibits of the Indiana and Kentucky Junior Academies of Science was a feature of the meeting and demonstrated the remarkable results which can be obtained under proper leadership.

ROGER C. SMITH, *Delegate.*

REPORT OF THE COMMITTEE TO STUDY EDUCATIONAL TRENDS IN SECONDARY SCHOOLS OF THE STATE WITH RESPECT TO BASIC SCIENCES

It became evident from a general consideration of sources of data that the most available and dependable data on the status of science education in Kansas high schools are the principals' reports which are filed in the State Department of Education at Topeka. Twenty-five dollars was allowed by the Kansas Academy of Science for obtaining the more significant data from these files. The data on general high-school enrollment; graduation; percent entering higher institutions; actual enrollments in nine different science courses; percent of all schools having classes in each of nine sciences; the grade location of science courses; the degrees of teachers teaching science courses; the hours of college preparation by the teachers of each of the different sciences; the sufficiency of equipment, facilities, and rooms for science courses; the number and length of laboratory periods; the amount of money spent annually for laboratory equipment; and the science books in high-school libraries have been obtained from the 1936-1937 reports of seventeen high schools in cities of the first class, seventy high schools in cities of the second class, and 148 high schools in cities of the third class. These schools include nearly all of the principal high schools in cities of the first and second class, and roughly twenty-five percent selected at random of those in cities of the third class. In addition, data were obtained for seventy high schools in cities of the second class for the school year 1929-1930. These data have been tabulated and summarized. Comparisons have been made between the high schools of the cities of the three different classes and between the two different school years. A paper covering these points is a part of this volume.

O. W. ALM, Kansas State College, *Chairman.*
A. C. CARPENTER, Ottawa.
MISS DALE ZELLER, Emporia.

REPORT OF COMMITTEE ON CONSERVATION AND ECOLOGY

The committee concentrated chiefly on the Academy's National Monument project at Rock City, near Minneapolis. A sixteen-page pamphlet describing the concretions and life of the proposed park site was prepared and published by the state printer. Several thousand of the 10,000 pamphlets furnished the committee by the state printer were distributed. As a result of an address given by the chairman to a group of over 200 persons at Minneapolis the "Rock City National Monument Association of Ottawa County, Kansas" was organized. This organization is taking active steps in promoting our project. In short, our effort this year was to make the people of Kansas park-minded and especially to "sell" them on the Rock City project.

The Pittsburg members of the Committee on Conservation are also working on the three following projects: (1) study of the reclaimed strip pit land for the purpose of determining what crops or plants may be grown profitably and successfully there, (2) a study of the acidity and alkalinity of water of the ten strip pit lakes for the purpose of determining their suitability for fish life, and (3) a study of the microscopic fauna and flora of the pit lakes for the purpose of determining if sufficient amount of food is present for the support of fish life.

Professor H. H. Hall has continued the work of labeling trees in the Pittsburg area.

COMMITTEE ON CONSERVATION AND ECOLOGY.

C. E. BURT, W. H. HORR,
H. H. HALL, C. O. JOHNSTON,
C. H. HIBBARD, W. H. MATTHEWS,
W. O. HILTON. L. D. WOOSTER,
W. H. SCHOEWE, *Chairman.*

REPORT OF THE COMMITTEE ON RESEARCH AWARDS FOR 1938

Name and Position of Applicant.	Amount granted.	Source of award.	Problem.	Money to be used for—
1. F. C. Gates. Professor of Taxonomy and Ecology, K. S. C., Manhattan.	$42.50	Academy	Distribution of flowering plants and ferns in Kansas and an ecological map of the state.	Hiring help and in transportation expenses.
2. Mary T. Harman. Professor of Zoölogy, K. S. C., Manhattan.	42.50	Academy	Development of pigment in hair and skin of guinea pigs.	Paying for the food, for help to take care of the animals, and help in preparing study materials.
3. Harry R. Bryson. Assistant Professor of Entomology, K. S. C., Manhattan.	25.00	A. A. A. S.	Elateridae of Kansas (fund needed to complete drawings).	Completing the drawings.
4. Roger C. Smith. Professor of Entomology, K. S. C., Manhattan.	25.00	A. A. A. S.	Identification of eggs of Middle West grasshoppers.	Photography.
5. Edwina A. Cowan. Director, Wichita Child Research Laboratory, Friends University.	40.00	$25.00—A. A. S and $15.00—Academy.	Test methods of determination of constitutional type (child research).	Purchase of a chronoscope.
6. John Breukelman. Professor of Biology, K. S. T. C., Emporia.	32.50	Albert T. Reagan fund	Distribution of Kansas fishes.	Transportation of field parties and specimens.

L. D. Wooster, Fort Hays State, Hays,
J. C. Peterson, Kansas State, Manhattan,
R. Q. Brewster, University of Kansas, Lawrence,
Kansas Academy Committee on Research Awards.

REPORT OF THE JUNIOR ACADEMY COMMITTEE

Dr. J. Ralph Wells, Kansas Junior Academy of Science, Contributing Editor

The Kansas Junior Academy of Science held its annual meeting on the campus of Kansas State Teachers College, Pittsburg, in the Horace Mann auditorium, Friday afternoon, April 2, in conjunction with the Kansas Academy of Science, with Oscar Klingman, president, presiding. No meeting in the history of this organization in Kansas was ever so largely attended nor so well received.

The phenomenal growth of the Kansas Junior Academy is evidenced by the fact that there are now seventeen affiliated science clubs, ten of which are new ones, with a total membership of more than two hundred. All but two of the clubs were represented at the meeting. In addition to these there were more than one hundred visitors, many of which were present to get a line on the work and ideas for use in organizing clubs for the coming year.

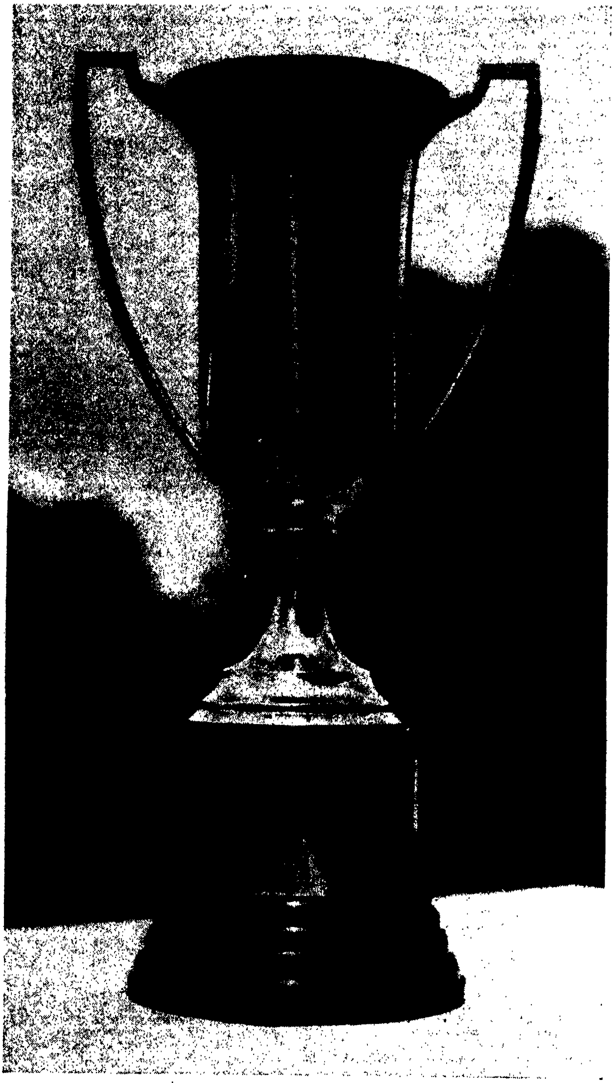
All the club members from distant high schools were guests of the college faculty members, students, fraternities, and sororities Friday night, and Saturday morning. The out-of-town Junior Academy members and visitors were entertained as far as possible, while not in their own program, by college student "guides" about the campus and by field trips to points of interest in the district, of which there is a great variety.

A new feature of this meeting was a banquet arranged in the college cafeteria annex, which is connected with the main cafeteria dining room in such a way as to make it possible for Junior Academy members to hear the program of the Senior Academy which was in progress in the main dining room at the same time.

The main program was long, but very interesting and varied. It was well received, and much evidence of high-grade work in the clubs was exhibited. In addition, many exhibits were on display in a special room set aside for all Senior and Junior Academy, as well as commercial exhibits. These were given a great deal of publicity throughout the whole meeting and they received much favorable commendation from the visitors and others present.

The following program, in which the winners are indicated after the respective names and projects, was rendered:

1. Induction Service for new clubs (sponsor and president of each of the following clubs):
   - Arkansas City Junior High School. Sponsor, Robley C. Guy.
   - Arkansas City Science Club. Sponsor, C. E. Ruff.
   - Cherryvale High School. Sponsors, Warren Willey and Daniel Simkin.
   - Columbus High School Junior Science Club. Sponsor, K. A. McClure.
   - Fort Scott High Science Club. Sponsor, Ross Anderson.
   - Galena High School Science Club. Sponsor, Robert Troughton.
   - Independence General Science Club. Sponsor, Parley W. Dennis.
   - Iola Junior High Science Club. Sponsor, Seth J. Owens.
   - Lakeside Junior High Science Club. Sponsor, J. Frank Hopkins.
   - Pittsburg High School Junior Academy. Sponsors, Chas Thiebaud, Claude I. Huffman, and Dora Peterson.
2. Arkansas City Science Club:
   - a. My Lepidoptera Collection. Phylis Lundy.
   - b. My Insect Collection. Earl Sheperd.
   - c. Aerodynamics. Wayne Conley.
   - d. Moving-picture Demonstration. Dick Curtis.
3. Ben Franklin Club (Lawrence):
   - a. Display of club projects.
4. Fort Scott Physical Science Club:
   - a. Homemade Reflecting Telescope. (Won 2d in individual contest).
5. General Science Club (Independence):
   - a. Anthropometrics Relative to a Skull Found Near Brown's Ford, Montgomery county, Kansas. Junior Stevens. (Honorable mention in individual contest).
   - b. Alkaloids. Junior Furnas.
6. Junction City Science Club:
   - a. Titles to be announced. (3d place in individual contest with a homemade oscillograph).



Won by 1938 Lawrence Junior High School Nature Club.

7. Junior High Nature Club (Lawrence) (1st place in group contest):
   a. Rocket Ships. Robert Bayles. (Honorable mention in individual contest.)
   b. Feeding Experiments with White Rats. Joanna Wagstaff.
   c. Plant Nutrition. Elizabeth Prentice.
   d. Wild Flowers. Lois Wheeler.
8. S. O. S. Club, Lakeside Junior High School (Pittsburg):
   a. Short Wave Radio Receiving and Sending Sets. Bob Green.
   b. The Marihuana Menace. Martin Lee.

9. P. H. S. Junior Academy of Science (Pittsburg) (3d in group contest):
   a. Demonstration—Dissection of a cat. Drury Love and Norma D. Stone.
   b. Does Milk Contribute to Adult Cancer? Bob Akey.
   c. Developing and Enlarging Films. Donald Slagle.
   d. Model Airplane Building. Harold Green. (1st place in individual contest.)

10. Chemistry Club (Wichita High School, East) (2d place in group contest):
   a. A projecting Microscope Which I Built. Charles Weikol.
   b. Indicators. Elfa Joy Stahl.
   c. Making Masks. Dorothy Brown'ee.
   d. Quackery Demonstration. Don Miller.
   e. Test for alcohol. Bob Johnson.
   f. Marihuana Test. George Steeples.
   g. Morphine Test. Kathryn Zacker.
   h. Character Sketch. Dorothy Brownlee.
   i. Movies. Jerry Preston.

11. Election of officers for the coming year.

12. Awarding of prizes.

A pleasant surprise was given the group while the program was in progress, when a telegram from Dr. Louis Astell, editor of "Science Club Service" was received and read.

In the election of officers, Bob Akey, of Pittsburg Senior High School, was made president and Dorothy Brownlee, Wichita High School, East, was chosen secretary. These officers will preside at the meeting in Lawrence next year.

REPORT OF THE RESOLUTIONS COMMITTEE

It is the opinion of the resolutions committee that the seventieth meeting of the Kansas Academy of Science now in session has been and is a most pleasant, enjoyable and successful one. The success of the meeting and the pleasure derived from it is, in a great measure, due to the hearty cordiality of the people of the city of Pittsburg and the Kansas State Teachers College of Pittsburg and the careful and painstaking preparation of the officers of the Academy and the local committee on arrangements.

Therefore, be it resolved, That the Kansas Academy of Science here assembled express their appreciation to:

1. The officers of the Academy for most careful and painstaking preparation for the meeting. Special mention should be given to our secretary, Dr. R. C. Smith, for his thoughtfulness in anticipation of every detail in preparation for the program and the work of the various committees, and to our editor, Dr. F. C. Gates, for the plans for publication of the records of the meeting and the papers presented.

2. To the local committee on arrangements for consideration of the comfort of their guests in housing them in most convenient places, and in arranging for delectable meals, and for entertainment while here.

3. To the college Cafeteria for the preparation and serving of these meals. Special mention should be made of the banquet on Friday evening.

4. To President W. A. Brandenburg and the Kansas State Teachers College of Pittsburg for the "Keys" to the college.

5. To the Chamber of Commerce of the city of Pittsburg who have cooperated with the local committee in arranging for the various trips around the city and the most interesting country near.

6. To the Southeast Kansas Section of the American Chemical Society for the lecture on Thursday evening, and to the local committee for the reception following that, and to the Kansas State Teachers College of Pittsburg for the lecture on Friday evening.

7. To everyone else who has helped in any way to make this meeting one long to be remembered.

8. Be it furthermore resolved, That the Academy send greetings to Dr. J. H. Harnly, Dr. L. C. Wooster, Dr. W. B. Wilson, Dr. J. Willard Hershey, who have been such faithful attendants of the Academy and who have been missed from this meeting: and to Mrs. Otilla Reagan who has established the Reagan Academy Award.

Very respectfully submitted,

MARY T. HARMAN, *Chairman.*
R. E. MOHLER,
PAUL MURPHY.

NECROLOGY

The committee on necrology presents obituaries of H. T. Groody, F. W. Cragin, V. L. Kellogg, and Warren Knaus.

ROY RANKIN, *Chairman*,
J. E. ACKERT,
R. H. BEAMER.

HAZLEY THOMAS GROODY—1883-1937

Hazley Thomas Groody was born in Washington, Kan., July 22, 1883, and died at Manhattan, Kan., June 2, 1937, having been a member of the Academy only two months.

Doctor Groody received a Bachelor of Science degree from Valparaiso University in 1909 and the degree of Doctor of Medicine from the Chicago College of Medicine and Surgery in 1913. He practiced in Barnes and Washington before moving to Manhattan in 1919. While he continued as a general practitioner until the time of his death, he had been, since 1925, assistant student health physician at Kansas State College.

Doctor Groody was a public-spirited citizen, being vice-president of the Board of Education of Manhattan, a past-president of the Riley County Medical Society, a past-president and past-secretary of the Coöperative Club, a member of the Chamber of Commerce, the Country Club, the Odd Fellows and of the Modern Woodmen of America. He was an elder in the Presbyterian Church and was physician for the Odd Fellows' Home.

Those of his immediate relatives who survive him are his widow, Marie M. Groody, three sons, Thomas, John and Joseph; two sisters, Mrs. E. E. Shannon, of Barnes, and Mrs. A. E. Roach, of Richland, Iowa; and a brother, R. M. Groody, of Richland, Iowa.

FRANCIS WHITTEMORE CRAGIN—1858-1937

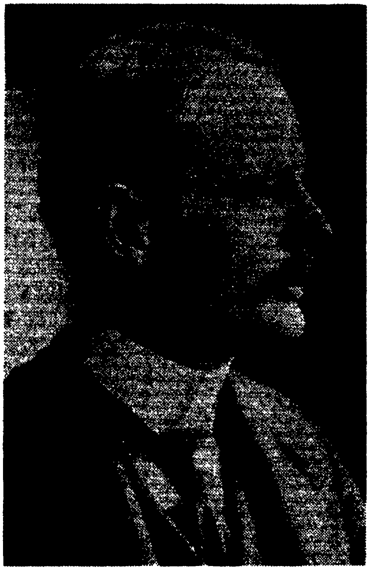
Prof. Francis W. Cragin had been absent from Kansas for so many years that it is probable that he is not remembered by many members of the Academy. He became a member of the Academy in 1880, and December 29, 1900, he was elected to life membership. His first contribution to the proceedings of the Academy was "A Preliminary Catalogue of Kansas Reptiles and Batrachians," published in Volume 7, page 114, 1879-'80. At that time he was a student in Harvard College. Later publications were "A Contribution to the History of the Fresh-Water Copepoda," "Second Contribution to the Herpetology of Kansas with Observations on the Kansas Fauna," "Preliminary Note on the Origin and Maturation of the Ovum in Porcellio," and "Note on a New Variety of a Sonoran Serpent from Kansas." There are numerous references to his work in the papers of other members.

Professor Cragin was elected the first librarian of the Kansas Academy of Science in November, 1884, and was appointed a member of the Board of Curators at the same time. He remained librarian until 1887 and was continued on the Board of Curators to a later date.

Professor Cragin was born in Greenfield, N. H., September 4, 1858. His early boyhood was spent in Wisconsin. The family removed to western Kansas in 1869. He studied in the preparatory department of Washburn College

from 1872 to 1875 and áttended Brooklyn Polytechnic Institute from 1875 to 1879. The collegiate year of 1880-'81 he devoted to special study in natural history at the Lawrence Scientific School, of Harvard College, and the summer of 1881, by invitation, he studied in the private laboratory of marine biology of Alexander Agassiz at Newport, R. I. In the fall of 1881 he entered the senior class of Lawrence Scientific School and was graduated *magna cum laude* in 1882.

Shortly after graduation he became professor of natural history in Washburn College, and retained the position until 1891. While there he published a series of "Bulletins" from the Washburn College Laboratory of Natural History.



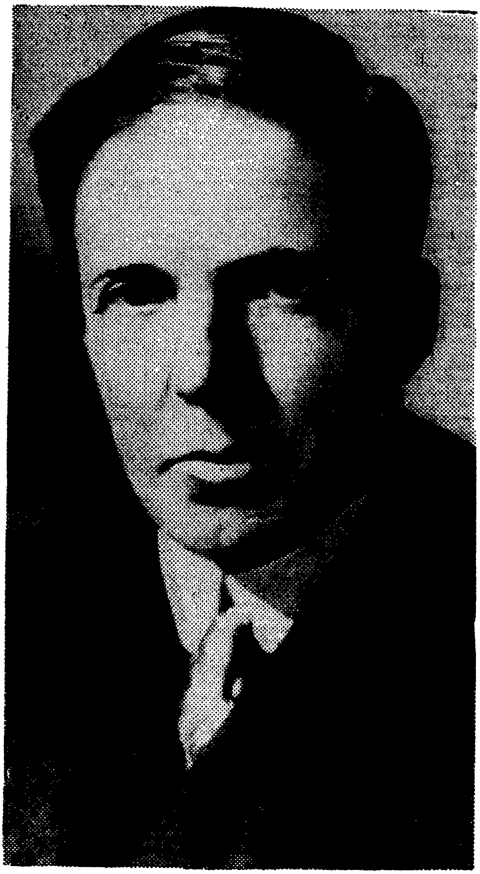
DR. FRANCIS WHITTEMORE CRAGIN

In 1891 he became professor of geology in Colorado College, Colorado Springs, Colo., where he remained until June, 1903. In 1893 he was on leave of absence and served as assistant geologist of the Geological Survey of Texas.

After 1903 he devoted the remainder of his life to research and writing, chiefly in lines related to the early history of the Far West, in connection with which he collected a valuable library. When his health failed in 1936, he was engaged in completing a three-volume set "Rocky Mountain Library," of which one volume on Coronado's Expedition of 1540-'42 was about ready for the printer. The other two volumes were partly written. Professor Cragin died June 15, 1937, in the hopsital of the Myron Stratton Home at Colorado Springs, where he had lived since the failing of his health.

Professor Cragin was an industrious and enthusiastic student and became greatly absorbed in any matter which he had in hand. He was an excellent teacher and an attractive speaker. Though his life was to a certain extent one

of disappointment, even frustration, he remained serene, tolerant, and generous in spirit. The writer visited him in the summer of 1936, and he was still optimistic in his plans for continuing his writing. A bright spot in his memory was a visit to Harvard University on the occasion of the fiftieth anniversary of the graduation of his class. That institution has the laudable practice of paying the expenses each year of those whose fiftieth anniversary of graduation occurs at that date. (Written by Dr. J. T. Willard.)



VERNON LYMAN KELLOGG

Vernon Lyman Kellogg, 1867-1937

Vernon Lyman Kellogg, noted scientist, teacher, author, student of life, promoter of scientific organizations, and citizen of the world passed to his reward on August 8, 1937. He was born in Emporia, Kan., on December 1, 1867, and spent his boyhood days there. In the nearly seventy years of his life he made the friendship of a remarkable group of eminent men. Among

them, mostly Kansans, were William Allen White, Frederick Funston, Herbert S. Hadley, the Franklin brothers, Edward C. and William S.; Henry E. Riggs, W. E. Borah, Francis Huntington Snow, David Starr Jordan and Herbert Hoover.

Born the son of a college president, Lyman B. Kellogg, Vernon began his scientific career by studying bird and animal life in the woods near Emporia. At eighteen he entered the University of Kansas, where he received his bachelor's and master's degrees. After graduation, he studied at Cornell University and at Leipzig. Various universities conferred upon him different varieties of doctor's degrees. Soon after the founding of Standford University, Doctor Kellogg took up his work there as an instructor in entomology and carried on biological research on silkworms. He was soon advanced to a full professorship and remained a member of the faculty for about twenty-five years. He was granted leave of absence to aid Herbert Hoover in the organization of the Belgian and Polish relief work.

After the World War, the services of Doctor Kellogg were so much in demand in numerous fields that he never returned to classroom teaching. He became a member of the board of the Rockefeller Foundation and was a member of a large number of scientific and educational organizations. In 1920, he was made a director of the National Research Council, supported by the Carnegie Foundation, and later became its permanent secretary, in which office he continued until severe illness forced him to relinquish it in 1932. At this time he was made secretary emeritus of the organization.

Many responsibilities came to this man and he seemed to carry them with ability and ease. He received with modesty and commendable meekness the many high honors that were justly bestowed upon him.

Warren Knaus, 1858-1937

Warren Knaus was born in Jay county, near Liber, Ind., February 24, 1858. He died June 28, 1937, at McPherson, Kan.

At the age of twelve Doctor Knaus moved west with his parents to a farm near Roper, Wilson county, Kansas, which farm he owned at the time of his death. After graduating from high school in 1876 he taught school for three years, and in the fall of 1879 entered the Kansas State Agricultural College. He graduated in 1882, receiving the degree of bachelor of science. During the next four years he taught school in Dickinson county and also held a position on the Salina *Herald*. In 1885 he obtained the master of science degree from the Kansas State Agricultural College. On October 1, 1886, there was issued in McPherson county the first democratic paper, called "The Democrat," which was edited and published by Doctor Knaus. In 1912 another democratic paper—"The Opinion"—which had been published for several years at McPherson, was purchased by Doctor Knaus and consolidated with the *Democrat* to form the *Democrat-Opinion*, which was owned and published by Doctor Knaus up to the time of his death. It was during 1880-1881, when Doctor Knaus was in the class of Entomology taught by Prof. Edwin A. Popenoe, who was an inspiring teacher and scientist, that he became intensely interested in insects, and began his hobby. Through the collection of beetles and exchange with other collectors, he not only developed a hobby which asserted

itself through his entire life, but also made him an outstanding systematic entomologist and an all-round naturalist.

For nearly fifty years Doctor Knaus spent the greater part of his spare time in making field trips to collect beetles in Kansas, Oklahoma, Colorado, Nebraska, Arizona, Texas, Nevada, New Mexico, California, Utah and Mexico. During all of this time he contributed valuable additions both to the Kansas lists of Coleoptera and to the lists of the Southwest. Approximately forty distinct species of beetles have been named or christened "Knausi." On one of his collecting trips to New Mexico he found a beetle which belonged to a new genus and bears the name of "Knausea." During these same years Doctor

WARREN KNAUS

Knaus corresponded with the most prominent Coleopterists throughout the world, and was recognized by them as an authority on beetles. Many of these men visited him at McPherson, Kan. For instance, Dr. Walther Horn, whom Doctor Knaus regarded as the greatest living Coleopterist, visited and collected with him in 1902.

The excellent private collection of North American Coleoptera, consisting of nearly 10,000 distinct species and nearly 90,000 specimens, was given by Doctor Knaus to the Kansas State College, his alma mater, in March, 1917. This valuable collection was transferred to the college on July 8, 1937, shortly after his death. His large scientific entomological library also was given to the college at that time. The collection is stored in a fireproof vault and the scientific library is in the college library.

In 1927 Doctor Knaus was awarded the honorary degree of Doctor of Science from the Kansas State College. McPherson College, McPherson, Kan., also awarded the honorary degree of Doctor of Science to Doctor Knaus. He

was made a member of the honorary society of Phi Kappa Phi of the Kansas State College chapter. In the spring of 1881, on the advice of Professor Popenoe, he joined the Kansas Academy of Science. He was a faithful member of the Academy for fifty-six years, its president in 1929, and at the time of his death was the oldest living member from the point of view of service. Doctor Knaus was also one of the founders of the Kansas Entomological Society in 1927, and in 1937 was its president. He was the publisher of the Journal of the Kansas Entomological Society.

During the forty-five years that the writer had the pleasure of knowing Doctor Knaus, he found him to be a generous, trustworthy, dependable and loyal friend. His whole life was one of service and he was most happy when serving others. To all who knew him the loss of his fellowship and rich experience is incalculable. In his death, systematic entomology has suffered a real loss and his associates, coworkers and friends in the United States, Canada, and many other foreign countries will feel intimately the loss of his fine generosity and stimulating influence.—GEO. A. DEAN.

REPORT OF THE NOMINATING COMMITTEE

W. H. Schoewe, president, Univ. of Kansas; H. H. Hall, president-elect, Kansas State Teachers College, Pittsburg; E. O. Deere, vice-president, Bethany College; Roger C. Smith, secretary, Kansas State College; H. A. Zinszer, treasurer, Fort Hays Kansas State College.

Executive Council (additional members): George A. Dean, Kansas State College; term expires 1939. Lawrence Oncley, Southwestern College; term expires 1939. R. H. Wheeler, Univ. of Kansas; term expires 1939.

Editorial Board: F. C. Gates, editor, Kansas State College; term expires 1941.

Associate Editors: Robert Taft, Univ. of Kansas; term expires 1941. R. E. Mohler, McPherson College; term expires 1941.

LAWRENCE ONCLEY, Southwestern.
J. E. ACKERT, Manhattan.
O. P. DELLINGER, Pittsburg.

ELECTED OFFICERS AND PERSONNEL OF THE STANDING COMMITTEES OF THE KANSAS ACADEMY OF SCIENCE 1938-1939 SEVENTY-FIRST ANNUAL MEETING, LAWRENCE, KANSAS

W. H. SCHOEWE, *President*, Lawrence
E. O. DEERE, *Vice-president*, Lindsborg
H. H. HALL, *President Elect*, Pittsburg
ROGER C. SMITH, *Secretary*, Manhattan
H. A. ZINSZER, *Treasurer*, Hays

EXECUTIVE COUNCIL

Additional Members

GEORGE A. DEAN, Manhattan
LAWRENCE ONCLEY, Winfield
R. H WHEELER, Lawrence

EDITORIAL BOARD

F. C. GATES, *Editor*
W. J. BAUMGARTNER, *Managing Editor*

ASSOCIATE EDITORS

G. A. KELLY
ROBERT TAFT
R. E. MOHLER
L. R. WEBER

CHAIRMEN OF SECTIONS

Botany—C. C. MCDONALD, Wichita; *Chemistry*—FAYETTE T. OWEN, Emporia; *Entomology*—L. C. WOODRUFF, Lawrence; *Geology*—D. C. SCHAFFNER, Emporia; *Junior Academy*—BILL AKEY, Pittsburg; *Physics*—PENROSE S. ALBRIGHT, Winfield; *Psychology*—JOSEPH W. NAGEE, Emporia; *Science Teachers, Biology*—LORENE BAILEY, Parsons; *Science Teachers, Physical Science*—LAWRENCE ONCLEY, Winfield; *Zoölogy*—EARL HERRICK, Manhattan.

STANDING COMMITTEES

(Appointed by President Schoewe)

DIVISION OF ACTIVITIES AND MAINTENANCE

Sponsor—H. H. HALL, *President Elect* (K. S. T. C.), Pittsburg

WORK OF THE DIVISION

1. To promote science, especially in Kansas.
2. To keep the Academy members active in research and doing well worth-while things for Kansas.
3. To maintain a high standard for the Academy in membership and in its research activities in order that the Academy may become and may be recognized as the outstanding scientific organization in the state.
4. To be ready to serve the state in any capacity called upon.

COMMITTEES

Conservation and Ecology

General Chairman—H. H. HALL (K. S. T. C.), Pittsburg
Parks—C. HIBBARD (K. U.), Lawrence
Fauna—C. E. BURT (S. W.), Winfield
Flora—L. E. MELCHERS (K. S. C.), Manhattan
Educational—R. C. MOORE (K. U.), Lawrence
Soil and Mineral—WM. MATTHEWS (K. S. T. C.), Pittsburg

SUBCOMMITTEES

Parks

C. HIBBARD (K. U.), chairman
E. O. DEERE (Beth.)
E. H. HERRICK (K. S. C.)
A. C. CARPENTER (Ottawa)
L. D. WOOSTER (F. H. K. S. C.)
K. K. LANDES (K. U.)

Fauna

C. E. BURT (S. W.), chairman
S. L. LOEWEN (Sterling)
J. BREUKELMAN (K. S. T. C.) Emporia
H. BRANCH (U. of Wichita)
M. J. HARBAUGH (K. S. C.)

Flora

L. E. MELCHERS (K. S. C.), chairman
C. C. MCDONALD (U. of Wichita)
W. H. HORR (K. U.)
J. H. DOELL (Bethel)
R. E. MOHLER (McPherson)
F. W. ALBERTSON (F. H. K. S. C.)

Educational

R. C. MOORE (K. U.), chairman
W. O. HILTON (Topeka)
A. B. SPERRY (K. S. C.)
MARGARET NEWCOMB (K. S. C.)
C. O. JOHNSTON (K. S. C.)
H. H. HALL (K. S. T. C.), Pittsburg
S. M. PADY (Ottawa U.)

Soils and Minerals

WM. MATTHEWS (K. S. T. C.), Pitt., chairman
L. C. AICHER (F. H. K. S. C.)
O. JONES (K. U.)
H. R. BRYSON (K. S. C.)
R. J. BARNETT (K. S. C.)

Duties

1. To create public interest in conservation by writing, lecturing and personal contact.
2. To represent the Academy when and wherever the matter of conservation has a bearing.
3. To coöperate with other conservation groups (State, Federal, National Research Council, American Ecological Society, etc.)
4. To promote the establishment of county, state and national parks and monuments in Kansas where conditions warrant such parks.
5. To educate the layman, boys and girls to our more common natural features (rocks, trees, etc.) by promoting the labeling of such features.
6. To study all conservation measures in order to be able to give expert opinion on such matters when called upon.

Objectives for 1938-'39

1. To get "Rock City" established either as a National Monument or State Monument.
2. To have labeled at least 10,000 trees and shrubs in the state in addition to those in our present state parks.
3. To have all rock formations labeled in our state parks.
4. To make a survey of the area known as the "Monument Rocks" and the "Sphinx" in southwestern Gove county for the purpose of determining the advisability of establishing a state park there.

Research Committee

L. D. WOOSTER (F. H. K. S. C.), chm.
R. Q. BREWSTER (K. U.)
P. G. ALLBRIGHT (S. W.)
J. C. PETERSON (K. S. C.)

Duties

1. To foster research among Academy members.
2. To be in charge of the Academy's research awards.

Objectives for 1938-'39

1. A study of the advisability of establishing an Academy Prize or Prizes.
2. Solicit requests for the annual research awards.
3. Grant as many research awards as possible.

Coördination of Scientific Groups

W. Warnock (F. H. K. S. C.), chm.
J. B. Stroud (K. S. T. C.), Emporia
W. J. Baumgartner (K. U.)
L. McKinley (U. of Wichita)
Rodney Babcock (K. S. C.)

Duties

1. To coördinate all of the scientific organizations of the state to the extent that they could act in unison in any matter of importance to all of them or to science in general.

Objectives for 1938-'39

1. To promote the organization of a "Kansas Coördinated Science Association" with (K. C. S. A.) or other initials.
2. Represent the Academy at the meetings of the K. C. S. A.
3. Keep the Academy informed of all activities of the K. C. S. A. and of any efforts to undermine science or scientific institutions in the state or elsewhere.

Committee on Natural History Handbooks

F. C. Gates (K. S. C.), chairman
D. C. Schaffner (C. of Emporia)
R. Beamer (K. U.)
E. J. Wimmer (K. S. C.)

Duties

1. To arouse an interest in the outdoors or physical world by writing handbooks on natural history for use by the layman and especially by young boys and girls.

Objectives for 1938-'39

1. Prepare a list of handbooks to be published by the Academy with prospective authors.
2. Make a study of handbooks already published for style, improvements, etc.
3. Publish at least one handbook from the biological science group—botany, entomology, zoölogy.
4. Publish at least one handbook from the physical science group—archaeology, astronomy, geology.

Membership Committee

Roger C. Smith (K. S. C.), chairman
Frank G. Agrelius (K. S. T. C.), Emporia
Paul Murphy (K. S. T. C.), Pittsburg
F. W. Albertson (F. H. K. S. C.)
Edith Beach, Lawrence

INSTITUTIONAL REPRESENTATIVES

Mary Larson (K. U.)
Ward Overholt (K. S. T. C.) Emporia
J. E. Ackert (K. S. C.)
C. E. Lane (Wichita U.)
Clara Hartley (Baker U.)
E. O. Deere (Bethany Col.)
F. T. Owen (C. of E.)
H. E. Crow (Friends U.)
W. S. Long (Kan. Wesleyan U.)
J. H. Doell (Bethel Col.)
Sister Mary Waring (Marymount)
J. W. Hershey (McPherson Col.)
Sister Anthony Payne (Mount St. Scholastica), Atchison
Wm. B. Wilson (Ottawa U.)
Paschal H. Bretz (St. Bendict Col.)
Sister Mary Zoe (St. Mary Col.) Leavenworth
D. Ruth Thompson (Sterling Col.)
R. B. Dunlevy (Southwestern Col.)
R. H. Kingman (Washburn Col.)
J. M. Schmidt (Tabor Acad. and Col.) Hillsboro

Duties

1. To invite scientists and others interested in science in Kansas to become annual members of the Academy.
2. To elect into membership those persons who have been nominated as annual members.
3. To recommend to the Academy for life membership those persons who

have met the qualifications set forth in Sec. 3, Art. 2 of the Constitution (as amended).
4. To present to the Academy for election as honorary membership the names of those individuals who have been recommended as specified in section 3, article 3 of the constitution (as amended).
5. To seek renewal of membership of those individuals who dropped their membership.
6. To present to the Academy at the annual meeting the names of all those elected as annual members during the year.
7. To provide members with annual membership cards.

Objectives for 1938-'39

1. To secure as an annual member every scientist on the permanent staff of every school of higher education in the state.
2. To secure as an annual member every science teacher in our secondary schools.
3. To secure the renewal of annual membership of 50 percent of those dropped during the last year.
4. To secure as annual members at least 10 individuals interested in science and not connnected with any of our schools.

Program Committee

ROGER C. SMITH (K. S. C.), chairman
E. BEACH (K. U.)
J. A. GLAZE (K. S. T. C.), Pittsburg
R. H. WHEELER (K. U.), chairman of local committee
E. E. BAYLES (K. U.)

Chairmen of Sections

Botany .... C. C. MCDONALD (Wichita)
Chemistry .... F. T. OWEN (Emporia)
Entomology .... L. C. WOODRUFF (Lawrence)
Geology .... D. C. SCHAFFNER (C. of Emporia)
Physics .... P. ALBRIGHT (S. W.)
Psychology .... J. W. NAGEE (Emporia)
Science Teachers .... L. ONCLEY (S. W.)
LOREEN BAILEY (Parsons Jr. College)
Zoölogy .... E. H. HERRICK (K. S. C.)
Junior Academy .... BILL AKEY (Pittsburg)

Duties

1. To prepare the program for the annual meeting.
2. To enlist scientists to prepare papers to be read at the annual meeting.
3. To enlist high-school science clubs to be represented on the program at the annual meeting of the Junior Academy.

Objectives for the 1939 Lawrence meeting

1. To have at least 50 science clubs represented on the program of the Junior Academy, either by papers, demonstrations, or exhibits.
2. To have outstanding guest speaker programs.
3. To have full sectional programs representing all branches of science.
4. To select only those papers for presentation at the general session or sessions that are of real general interest.

Committee on Necrology

ROY RANKIN (F. H. K. S. C.), chairman
L. D. BUSHNELL (K. S. C.)
H. J. HARNLEY (McPherson Col.)

Duties

1. To ascertain the deaths of all Academy members during the year.
2. To prepare suitable obituaries, with photographs of all present and former members of the Academy dying during the year, for publication in the TRANSACTIONS.

3. To furnish the editor-in-chief of the TRANSACTIONS with the obituary manuscripts to be published in the TRANSACTIONS.
4. To hold a brief memorial service for those deceased during the year, at the business meeting or other designated time at the annual meeting.

Committee on New Sections

E. O. DEERE (Bethany), chairman
G. A. DEAN (K. S. C.)
H. H. HALL (K. S. T. C.), Pittsburg
W. H. SCHOEWE (K. U.)
ROGER C. SMITH (K. S. C.)

Duties

1. To foster new sections in those branches of science not yet represented or organized in the Academy.

Objectives for 1938-'39

1. Promote and organize a section for Medicine.
2. Promote and organize an Engineering section.
3. Promote and organize a Mathematics section.

DIVISION OF SCIENCE IN SECONDARY SCHOOLS

Sponsor—G. A. DEAN, Past President, (K. S. C.)

WORK OF THE DIVISION

1. To promote science in the secondary schools.

COMMITTEES

Junior Academy

EDITH BEACH (K. U.), general chairman
J. R. WELLS (K. S. T. C.), Pittsburg
J. A. BROWNLEE (Wichita)

SUBCOMMITTEES

GERALD TRAVIS (Norton), Division I; J. D. SCHWARTZ (Dodge City Jr. Col.), Division II; E. C. ALMQUIST (Hutchinson), Division III; MAUD GORHAM (F. H. K. S. C.), Division IV; H. R. CALLAHAN (Junction City), Division V; ABIGAIL MCELROY (Topeka H. S.), Division VI; C. E. RUFF (Arkansas City), Division VII; J. R. WELLS (K. S. T. C., Pittsburg), Division VIII; J. M. JEWETT (K. U.), Division IX; H. A. STEPHENS (Atchison) Division X.

Duties

1. To promote interest in science in our secondary schools.
2. To establish science clubs in our secondary schools.
3. To promote affiliation of science clubs in our secondary schools with the Kansas Junior Academy of Science.
4. To arrange for the Junior Academy program for the annual meeting, urging each affiliated club to be represented.
5. To furnish science teachers of our secondary schools with material and suggestions for science club programs.
6. To publish a bulletin several times during the year containing material useful to the affiliated science clubs.
7. To serve as judges in the annual Junior Academy program and to award prizes to those individuals and clubs judged best.
8. To study the development of the Junior Academy in the United States with the idea of bettering our own Junior Academy and making recommendations for its improvement to the Senior Academy.

Objectives for 1938-'39

1. To promote the organization of at least one science club in each of the 105 counties in the state.
2. To secure the affiliation of 105 science clubs with the Junior Academy.
3. To have at least 50 science clubs represented on the program of the Junior Academy by either a paper, demonstration or exhibit.

4. To publish and distribute at least twice during the year a mimeographed (or other) bulletin containing information helpful to science clubs.
5. To make a survey of the Junior Academy movement in the United States.

Committee on Educational Trends

J. A. Glaze (K. S. T. C.), Pittsburg, chairman
O. W. Alm (K. S. C.)
U. G. Mitchell (K. U.)
V. T. Smith (Kan. Wes.)
H. B. Reed (F. H. K. S. C.)
B. Nash (K. U.)
R. H. Wheeler (K. U.)
P. D. Schultz (Friends U.)

Duties

1. To study the educational trends in the secondary schools of the state with respect to the basic sciences.

Objectives for 1938-'39

1. To make a general survey of the science curriculum of high schools in the state.
2. Special study of the place of mathematics in our high schools with purpose of making definite recommendations to the State Superintendent of Schools in regard to the importance of high-school mathematics for entrance to college.

Committee on Science Teaching

E. E. Bayles (K. U.), chairman
E. H. Kroeker (Bethel)
R. Litwiller (Kan. Wes.)
H. E. Schrammel (K. S. T. C.), Emporia
J. A. Trent (K. S. T. C.), Pittsburg
L. E. Hudiburg (K. S. C.)
G. A. Kelly (F. H. K. S. C.)
L. Oncley (S. W.)
Lorene Bailey (Parsons Jr. Col.)

Duties

1. To study and keep informed on the development of science teachers' associations, especially those pertaining to secondary schools in the United States.
2. To study methods and means of improving the teaching of science in our secondary schools.
3. To keep the Academy members informed on new teaching methods in science.
4. To be responsible for a Science Teaching section at the annual meeting with a well-prepared program of addresses and round table discussions.

Objectives for 1938-'39

1. To arrange for a Science Teaching section (if not already in existence).
2. Plan a symposium on some phase of science teaching.
3. Plan discussion groups or round tables for the various branches of science.

Division of Finance

Sponsor—E. O. Deere, *Vice-president* (Bethany College)

WORK OF THE DIVISION

1. To devise ways and means of raising money for the Academy in addition to the regular income from dues.
2. To solicit money for the Academy.

Committee on Coördinating Finance

H. Zinszer (F. H. K. S. C.), chairman
W. E. Grimes (K. S. C.)
R. Taft (K. U.)
C. E. Rarick (F. H. K. S. C.)
W. J. Baumgartner (K. U.)

Duties

1. *To prepare and submit a financial statement of all money raised and give an account of all investments made for the Academy at the regular annual meeting.*
2. To be the clearing house for all of the committees in the Division of Finance.

Committee on Endowments and Investments

W. E. GRIMES (K. S. C.), chairman
DEAN L. E. CALL (K. S. C.)
G. A. DEAN (K. S. C.)
MARTHA S. PITTMAN (K. S. C.)
R. K. NABOURS (K. S. C.)
H. ZINSZER (F. H. K. S. C.)

Duties

1. To devise ways and means of raising money for an endowment for the Academy and to solicit such money.
2. To invest the money raised for the Academy wisely and safely.
3. To coöperate with and report to the Coördinating Finance Committee.

Objectives for 1938-'39

1. To increase the present endowment by $1,000.

Committee on Research Fund

R. TAFT (K. U.), chairman
L. WOODRUFF (K. U.)
M. W. MAYBERRY (K. U.)
D. OBEE (K. U.)
R. W. WARNER (K. U.)
L. D. WOOSTER (F. H. K. S. C.)
H. ZINSZER (F. H. K. S. C.)

Duties

1. To devise ways and means for raising and to raise money for purposes of research.
2. To turn over to the Academy treasurer all money raised.
3. To coöperate with and report to the Coördinating Finance Committee.

Objectives for 1938-'39

1. To increase the present research award fund to $500.

Committee on Publication Fund

C. E. RARICK (F. H. K. S. C.) chm.
H. ZINSZER (F. H. K. S. C.)
A. W. BARTON (F. H. K. S. C.)
F. W. ALBERTSON (F. H. K. S. C.)
F. B. LEE (F. H. K. S. C.)

Duties

1. To devise ways and means for raising and to raise money for the publication of the Natural History Handbooks.
2. To turn over to the Academy treasurer all money raised.
3. To coöperate with and report to the Coördinating Finance Committee.

Objectives for 1938-'39

1. To raise $200 for plates for use in connection with the publication of Natural History Handbooks.

Committee on State Aid

WM. J. BAUMGARTNER (K. U.), chairman.
Other members to be selected by chairman later.

Duties

To solicit appropriations from the state legislature for the use of the Academy.

2. To coöperate with and report to the Coördinating Finance Committee.

Objectives for 1938-'39

1. To increase the $300 annual grant from the State Legislature to $500 annually.

ANNUAL COMMITTEES

Nominating Committee

W. MATTHEWS (K. S. T. C.), Pitt., chairman
J. W. HERSHEY (McPherson Col.)
W. J. BAUMGARTNER (K. U.)
L. ONCLEY (S. W.)
G. A. DEAN (K. S. C.)

Duties

1. To nominate members in good standing to the regular offices of the Academy.

Officers to be elected for 1939-1940

1. President-elect
2. Vice-president
3. Secretary
4. Treasurer
5. Additional member of executive council
6. Additional member of executive council
7. Additional member of executive council
8. Associate-editor
9. Associate-editor

Auditing Committee

A. BERNHART (Ottawa U.), chairman
E. R. LYON (K. S. C.)
W. A. HARSHBARGER (Washburn Col.)

Duties

1. To audit the books of the Academy treasurer and report to the Academy at one of its regular business sessions.

Resolutions Committee

O. P. DELLINGER (K. S. T. C.) Pittsburg, chairman
R. E. BUGBEE (C. of Emporia)
BERNICE KUNERTH (K. S. C.)

Duties

1. To make such resolutions as the occasion demands.

Local Committee

R. H. WHEELER (K. U.), chairman
W. J. BAUMGARTNER (K. U.)
C. HIBBARD (K. U.)
J. M. JEWETT (K. U.)
M. W. MAYBERRY (K. U.)

Duties

1. To make all local arrangements for the annual meeting, and to provide the guest speakers for the two evening addresses. See Manual of Instructions and Suggestions for the Local Committee to be had from the Secretary.

Objective for the 1939 Lawrence meeting.

1. To have the best annual meeting ever held.

Publicity Committee—W. A. DILL (K. U.)

Toastmaster—H. H. HALL (K. S. T. C.), Pittsburg

The work of the Academy must be done almost wholly by the officers and committees. This announcement is being sent to all officers and committee members so that all may be reminded of the responsibilities given them and that they may function effectively during the year. The president of the Academy may properly be regarded as an *ex officio* member of all committees.

REPORTS

(1) The president is going to call for reports of progress from each of the standing committees at least twice before the annual meeting. Reports of progress are to be made in September and in December in duplicate on special blanks sent by the sponsors of the divisions to which the committees belong. It is expected that all committees will submit their reports to their respective sponsors promptly whether progress has been made or not.

(2) The final report of each standing committee will be printed in the annual program. Except for matters of unusual importance calling for special discussion and action, the chairman of each committee when called upon is requested to refer to his committee's report as printed on the program and immediately move for its adoption. This procedure will greatly reduce the time devoted to the business meeting and also furnish each member with a complete record of the Academy's progress during the year. Furthermore, it will invite more intelligent discussion on matters which need to be considered more fully by the Academy. Calls for the final reports will come through the sponsors, to whom the reports should be sent in time to be submitted later to the secretary for printing in the program about March 10.

W. H. SCHOEWE, *President.*
ROGER C. SMITH, *Secretary.*

PAPERS AND ABSTRACTS

SEVENTIETH ANNUAL MEETING, PITTSBURG, 1938

The Contribution of Kansas to the Science of Entomology[1]

GEO. A. DEAN, Kansas State College, Manhattan, Kan.

For more than seventy years entomology, the study of insects and related forms, has received special attention at the Kansas State College and the University of Kansas. During this time Kansas has contributed much to the science of entomology, not only in the training of more than two hundred men and women who have held or are at the present time holding important entomological positions in many countries of the world, but also in publishing hundreds of valuable articles. Many of these published articles have been real contributions to the science of entomology. Some of the nation's most outstanding museum collections of insects were made by these men. From their investigations have developed several of the important methods of insect control and discoveries contributing to the marvelous development of agriculture, the health of man and domestic animals, and the advancement of civilization.

INSTRUCTION IN ENTOMOLOGY

"Insects Injurious to Vegetation," a subject taught by Prof. Benjamin Franklin Mudge at the Kansas State College in the year of 1866-'67, was the first course offered in economic entomology in the United States, and probably in the world. From that time there has been no interruption in the teaching of entomology at the Kansas State College. Professor Mudge gave the course in entomology up to 1873, with the exception of 1872-'73 at which time he invited Dr. C. V. Riley, the famous state entomologist of Missouri, to give the course. The forty or more excellent colored charts which Doctor Riley prepared and used in giving this course in entomology at the Kansas State College were given to the college a few years ago by Mrs. C. V. Riley, and are still in good condition. To Professor Mudge much credit must be given for the founding of the Kansas Academy of Science. In recognition of his valuable services and great scientific achievements, he well deserved the honor of having been elected its first president in 1868.

One of the students who took the course offered by Professor Mudge was Samuel Wendell Williston, who graduated in 1872. Doctor Williston, who later became a world authority in paleontology and on the insect order Diptera, is often referred to as one of Kansas State College's most illustrious sons. No alumnus of the institution was ever more loyal and interested in its welfare than Doctor Williston. He frequently visited his Alma Mater, and on several occasions the writer has heard him tell how he became interested in paleontology and entomology through his inspiring teacher, Professor Mudge, whom he frequently accompanied on collecting trips to the various Kansas fossil beds.

It may also be of interest to know that at the time of writing this article (1938) Professor Mudge has a daughter, Mrs. Irish, living at Manhattan, who was a student at the Kansas State College at the time he was professor of

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Contribution No. 460 from the Department of Entomology.

natural sciences. Mrs. Irish not only took the course offered by her father in entomology, but also took the course offered by Dr. C. V. Riley.

Early emphasis also was given to entomology at the University of Kansas. Doctor Francis Huntington Snow, one of the three professors comprising the faculty at the opening of the state university in September, 1866, soon began his activities in the study of insects. It is also evident that entomology was given considerable attention by Doctor Snow in his natural science course in the university, for there is in the University museum a student collection of insects made in the course work in 1872 by a Miss Richardson, a member of the first graduating class of the university. Dr. H. B. Hungerford, professor of entomology, University of Kansas, in a recent article states, "While it is apparent that the study of insects was given a prominent place in the teaching of biology from the very beginning, and a considerable place in the research work done by Doctor Snow and by students even in the first decade of the university's existence, it was not until 1886 that special advanced courses in entomology were offered officially."

INSECT COLLECTIONS

A. Univerity of Kansas

Doctor Hungerford, in a recent report concerning the Francis Huntington Snow entomological collection, states: "According to those in the best position to judge, the University of Kansas has the best general collection of North American insects in connection with any university. There are some collections which surpass it in special groups, but considering all orders and the extensive annual additions, none surpass it. It is surprisingly rich in types and has profited greatly by the various workers in the museum itself. S. W. Williston, J. M. Aldrich, C. H. T. Townsend, V. L. Kellogg, Hugo Kahl, C. F. Adams, H. L. Vierrick, F. X. Williams, C. P. Alexander, R. H. Beamer, H. B. Hungerford, and others for shorter periods, contributed immeasurably to the richness of the collections in types and determined species, a work which has been continued by the present departmental staff, four of whom are taxonomists. The Francis Huntington Snow Entomological Museum, as it is officially known, contains more than a million insects, including some 20,000 types."

Persons not familiar with the collecting, mounting, labeling, classifying, and the arranging of insects for a valuable permanent collection can little realize the tremendous amount of laborious, careful, and painstaking work involved in making a large insect collection. In making the Francis Huntington Snow insect collection, biological survey parties have collected insects in every county in Kansas and in most of the states of the Union. The first out-of-the-state survey or expedition was made by Doctor Snow and some of his students in 1874. The first twenty-nine expeditions were led by Doctor Snow. These expeditions were made in Kansas and the southwestern states. In all, the staff members and students in entomology of the University of Kansas have made fifty-one insect-survey trips. These surveys or extension activities in many parts of America have added greatly, not only to the knowledge of insect life in America, but also have made available for study a great collection of insects for students throughout the world. In speaking of the insect collections secured from foreign countries, Doctor Hungerford, curator

of the entomology museum of the University of Kansas, states: "In certain groups of insects where studies in world distribution have been involved in research activities, collections have been secured over a long series of years, with the result that the Francis Huntington Snow insect museum has the finest collection in the world in these groups."

B. Kansas State College Collection

Dating from 1879, and containing contributions from many faculty members, students, and alumni of the department, the insect collection of the Kansas State College has become an excellent representative collection of the species of insects which occur in Kansas. At the present time (1938) the collection consists of about 120,000 specimens, of which the first contributions to the collections were made by Prof. E. A. Popenoe. Professor Popenoe began his work in entomology, horticulture, zoölogy, and botany at the Kansas State College in 1879, and in 1894 was made head of the department of entomology and zoölogy. He held this position continuously, except during 1897 and 1898, until July 1, 1907, at which time he retired to live on his farm near Topeka. During the past 35 years the chief contributions have been made by Professors Geo. A. Dean, J. W. McColloch, W. P. Hayes, Roger C. Smith, R. H. Painter, D. A. Wilbur, and H. R. Bryson. Many former students and alumni of the department also have added specimens to the collection. This valuable collection is very useful to the students and faculty in the department in connection with Experiment Station research projects, in the teaching work, and in the preparation of state lists of insects.

C. The Warren Knaus Collection

Warren Knaus entered the Kansas State Agricultural College in the fall of 1879 and graduated in 1882. Later he returned to take graduate work in entomology, and obtained the master of science degree in 1885. It was during 1880-'81, when Mr. Knaus was in the class of entomology taught by Prof. Edwin A. Popenoe, an inspiring teacher and scientist, that he became intensely interested in insects and began insect collecting as his hobby. Through the collection of beetles, and exchange with other collectors, he developed a hobby which asserted itself through his entire life, and made him an outstanding systematic entomologist, as well as an all-round naturalist.

For nearly fifty years Doctor Knaus, editor and publisher of the *Democrat-Opinion,* McPherson, Kan., spent the greater part of his spare time in the field collecting beetles in Kansas, Oklahoma, Colorado, Nebraska, Arizona, Texas, New Mexico, California, Utah and Mexico. During this time he contributed valuable additions to the Kansas lists of Coleoptera and to lists of beetles in the Southwest. Approximately forty distinct species of beetles have been named or christened "knausi." On one of his collecting trips to New Mexico he found a beetle belonging to a new genus, which bears the name "knausea." Doctor Knaus corresponded with the most prominent coleopterists throughout the world, and was recognized by them as an authority on beetles. Many of these men visited him at McPherson, Kan. For instance, Dr. Walther Horn, of Berlin, Germany, whom Doctor Knaus regarded as the greatest living coleopterist, visited and collected with him in 1902.

This excellent private collection of North American Coleoptera, consisting

of nearly 10,000 distinct species and nearly 90,000 specimens, was given by Doctor Knaus to the Kansas State College, in March, 1917. The valuable collection was transferred to the college on July 8, 1937, shortly after his death, and stored in a fireproof vault. His large scientific library also was given to the college at that time, and has been placed in the college library.

In 1927 the Kansas State College conferred on Doctor Knaus the honorary degree of doctor of science. McPherson College, McPherson, Kan., also awarded the honorary degree doctor of science to Doctor Knaus. In the spring of 1881, on the advice of Professor Popenoe, Mr. Knaus joined the Kansas Academy of Science. He was a faithful member of the Academy for 56 years, its president in 1895, and at the time of his death was the oldest living member from the point of view of service. All who knew him found him to be a generous, trustworthy, dependable and loyal friend. His whole life was one of service, and he was most happy when serving others.

D. The Ferdinand F. Crevecoeur Collection

Mr. F. F. Crevecoeur, born June 23, 1862, moved with his mother to a farm near Onaga, Kan., in the spring of 1870. Although he had only a third-grade education, he found much in the interesting life all about him to attract his attention, and he became thoroughly versed, entirely through his own efforts, in entomology, zoölogy, botany, surveying, meteorology, and physics. He was one of those old-time naturalists who studied nature because he loved the out-of-doors. By correspondence, Mr. Crevecoeur made the acquaintance of such men as Doctor Knaus, Doctor Snow, Prof. B. B. Smyth, Prof. L. C. Wooster, Prof. H. F. Wickham, H. C. Fall, E. P. Van Duzee, and Dr. J. M. Aldrich. Some of these men he met at the annual meeting of the Kansas Academy of Science in Topeka in 1899, which meeting he attended on the invitation of Doctor Knaus. In 1917 he sold his collection of insects, plants, and several animal groups to Ottawa University. He found that the time required to farm an 80-acre farm and keep house, which he did after his mother died in 1908, did not permit him to take the proper care of the large number of specimens in his collection. However, he could not resist the impulse of collecting, especially insects, and from 1917 to the time of his death, April 11, 1931, he made a second collection of insects.

Prof. L. C. Wooster gave a summary of Mr. Crevecoeur's collection, which went to Ottawa University, in his annual address to the Kansas Academy of Science in 1906. The summary included quite a range of plant and animal groups, comprising a total of 14,126 specimens and 6,502 species.

It was the intention of Mr. Crevecoeur to give his second collection of insects, together with his scientific library, consisting of over 3,000 volumes and bulletins, to the Kansas State College. However, after his sudden death his will was found unfinished and unsigned. While it indicated that his scientific library and insect collections were to be given to the Kansas State College, his encyclopedia and dictionaries to the local schools, and the remainder of his estate, amounting to many thousand dollars, to the building of a community house at Onaga, his intentions, of course, legally could not be carried out. The Kansas State College, however, purchased at public auction sale the insect collection and the greater part of his scientific library. The insects, which filled 186 cigar boxes, have been placed in the steel cabinets in the department of entomology.

FOSSIL INSECT BEDS

While the Permian period has long been recognized as the period of most rapid evolution of the insects, the fossil records of the period remained nearly a blank until within the last thirty years. In 1906, when Handlirsch published his revision of the fossil insects of the world, only 14 specimens, other than cockroaches, had been taken from the rocks of this period. Within recent years, however, the discovery of new and very productive Permian beds, especially the important Lower Permian fossil beds in Kansas, has made possible the addition to the records of such a large number of well preserved fossils that knowledge relative to the Permian insects now probably surpasses that of any other Pretertiary horizon.

Most of these new fossils have been taken in the Lower Permian beds of Kansas, located about three and one half miles southeast of the town of Elmo, Dickinson county. This great fossil bed has already yielded 10,000 or more specimens, one of which was a giant dragon fly with a wing expanse of nearly 30 inches, or the largest insect fossil on record. This specimen was taken about two years ago (1936). The first insects were found in this fossil bed in 1899, among a collection of plant fossils obtained by Dr. E. H. Sellards, in the Wellington shales southeast of Elmo. In examining the collection during the winter of 1899, Doctor Sellards found two fossil wings. He realized the importance of his discovery and returned to the locality during the summers of 1902 and 1903 and collected about 2,000 specimens. Between 1906 and 1909 Doctor Sellards published three papers on his collection. While it was his intention to publish a revision of the fossils, other work prevented him from doing so, and the large collection was stored in his home at Austin, Tex. In the spring of 1927 Dr. F. M. Carpenter, of Harvard University, received a grant from the National Academy of Science to visit Doctor Sellards, who not only kindly permitted him to examine and study his types, but the following year sent his entire unworked collection to the Bussey Institute for study.

In the meanwhile a second collection of insects had been obtained at the Elmo beds. Dr. R. J. Tillyard, an eminent entomologist of the Cawthron Institute, New Zealand, and later entomologist of the Commonwealth of Australia, passed through the country in 1920, and while visiting Yale University, saw a small series of the Kansas specimens which Doctor Sellards had donated to the Peabody Museum, Yale University. Doctor Tillyard aroused interest in these fossil insects, and the following summer Prof. C. O. Dunbar, professor of paleontology of Yale, made an expedition to the Elmo locality. He collected about 2,000 specimens, which were sent to Doctor Tillyard for study. From 1924 to 1932 Doctor Tillyard published fifteen splendid papers on this fauna. Since 1932 five additional papers have been published by Doctor Tillyard. The Yale University specimens remain the property of the Peabody Museum.

In 1928 Doctor Carpenter, with the assistance of two graduate students in entomology, obtained about 2,400 specimens, comprising the third and largest collection from the Elmo formations. All of the specimens probably will be placed in the Museum of Comparative Zoölogy, Harvard University, when Doctor Carpenter's studies of them have been completed. During the past seven or eight years two or three thousand more specimens have been taken by Kansas University, Kansas State College, Harvard University, and others.

Since the fossil insects of the Elmo formations are definitely placed in the Lower Permian stratum they are the oldest of any of the Permian forms which have been discovered. The studies and researches which have been conducted on these Kansas Lower Permian insects by Tillyard and Carpenter already have filled in many gaps in the phylogenetic tree of insects, and with the many thousands yet to be studied some of the uncertainties which have existed should be cleared up and further progress made. Thus, up to the present time, Kansas has contributed the most remarkable deposit of Permian insects which has ever come to light.

RESEARCH CONTRIBUTIONS

The entomologists of the Kansas State College, Kansas University, and the United States entomological laboratories located in Kansas, have contributed much to the classification, biology and life history studies, and to the development of practical methods of control of injurious insects. Many of the methods of control have become widely used not only throughout the United States, but also, in some instances, throughout the world. The University of Kansas has published to date (1938) 509 papers, several of which are extensive and monographic in nature. The Kansas State College has published to date 453 papers, as bulletins and circulars of the Kansas Agricultural Experiment Station and as contributions to scientific journals and reports of scientific organizations. These papers, together with those published by the late Dr. Warren Knaus, the federal entomologist stationed in Kansas, and others, make a list of not less than 1,100.

ENTOMOLOGICAL CLUBS AND THE KANSAS ENTOMOLOGICAL SOCIETY

The Popenoe Entomological Club, of the Kansas State College, was organized on February 21, 1921, and named after the able coleopterist, Edwin A. Popenoe. The Entomological Club of the University of Kansas was organized in 1910. The object of these two clubs has been chiefly to serve as a medium for the discussion of entomological problems and new discoveries, the exchange of experience, to propose investigations, and to create interest, profitable and friendly relationships, and good spirit among the staff members and students in entomology. These two entomological clubs sponsored the foundation, April 9, 1925, of the Kansas Entomological Society, which at the present time consists of 25 regularly employed entomologists in Kansas and many advanced students majoring in entomology at Kansas University and Kansas State College. The entomologists and graduate students of entomology of Nebraska, Oklahoma, Arkansas, and Colorado are also included. The Kansas Entomological Society has created a friendly relationship and good spirit of coöperation among the groups. This society also sponsors the quarterly publication of the *Journal of the Kansas Entomological Society,* now in its eleventh volume.

A LIST OF KANSAS STATE COLLEGE STUDENTS

Who Have Held Entomological Positions or Have Contributed to Entomological Literature

Abbott, Cyril, '28. Instructor in Zoölogy, Chicago University, 1231 Hermosa Ave., Chicago, Ill.

Adams, C. D., '95. Chief Inspector of Apiaries, Madison, Wis.

Allen, Merle W., '34. Teacher in Biology, Junior College, Fort Scott, Kan.

Audant, André, '31. Entomologist, Port-au-Prince, Haiti.

Bahgat, M. M., '22. Formerly Entomologist and Plant Pathologist, Dept. of Agr., Cairo, Egypt. At present with the Egyptian embassy, Washington, D. C.

Balzer, A. I., '26. Assist. Ento., Bur. of Ent. and Pl. Quar., Beamount, Tex. (In charge of station.)

Blachly, John W., '18. Formerly Entomologist and Horticulturist of the Kansas City, Mo., Forestry Dept., Kansas City, Mo. Now at Oklahoma City, Okla.

Blood, Everett, Major in Ent. '38. Kansas State College, Manhattan, Kan.

Boyd, Fred W., '21. Formerly Assist. Ent., Bur. of Ent. and Pl. Quar., San Antonio, Tex. At present at Toppenish, Wash., Box 442 (County Agent).

Bruce, W. G., '28. Assoc. Ent., Bur. of Ent. and Pl. Quar., Dallas, Tex.

Bryson, Harry R., '17. Assist. Prof. of Ent., Kansas State College, Manhattan, Kan.

Bushland, R. C., Graduate Student, '35. Junior Ent., Bur. of Ent. and Pl. Quar., Dallas, Tex.

Caler, H. L., '31. Bur. of Ent. and Pl. Quar., Addison, Me.

Collins, C. R., '33. Rural Rehabilitation Supervisor, U. S. D. A., Norton, Kan.

Copenhafer, Lloyd M., '36. Assist. Landscape Architect, Kansas Highway Commission, Topeka, Kan.

Curtiss, A. C., Graduate Student, '38. Kansas State College, Manhattan, Kan.

Dahms, Reynold, '35. Assist. Ent., Oklahoma A. & M. College, Stillwater, Okla.

Davidson, A. P., '19. Professor of Vocational Education, Kansas State College, Manhattan.

Davis, E. W., '24. Assist. Ent., Bur. of Ent. and Pl. Quar., Modesto, Cal.

Dean, Geo. A., '95. Prof. of Ent. and Sta. Ent., Kansas State College and Kansas Agr. Exp. Sta., Manhattan, Kan.

Dean, Marjorie, '33. (Now Mrs. H. L. Nonamaker.) Smith Center, Kan.

DeMoss, Noblesse, '37. (Now Mrs. Boyd Hill.) Manhattan, Kan.

Dillon, Geo. Franklin, Graduate Asst. in Ent. '38. Kansas State College, Manhattan, Kan.

Dirks, C. O,, '24. Assist. Prof. of Ent., Univ. of Maine, Orno, Me.

Douglas, J. R., '23. Assoc. Ent. Bur. of Ent. and Pl. Quar., Box 110, Twin Falls, Idaho. (In charge of Sugar Beet Station.)

Durham, J. Edgar, '27. Formerly Entomologist for the Flour Export Trade Service, Galveston, Tex. At present Assist. Sec., Manhattan Chamber of Commerce, Manhattan, Kan.

Falls, Olive, Graduate Student '33 and '34. Research Ent., American Lumber Treating Co., Chicago, Ill.

Farrar, Clayton L., '26. Assoc. Ent. Bur. of Ent. and Pl. Quar., Laramie, Wyo.

Filinger, Geo. A., '25. For Several Years Assist. Ent., Ohio Agr. Exp. Sta., Wooster, Ohio. Now Assist. Prof. of Horticulture, Kansas State College, Manhattan, Kan.

Ford, Anson Lane, '16. Prof. of Ext. Ent., S. D. Agr. College, Brookings, S. D., until 1935. Now in charge of the shelter-belt work in South Dakota.

Fritz, Roy, Graduate Student, '38. Kansas State College, Manhattan, Kan.

Gahan, Arthur Burton, '03. Senior Ent., Bur. of Ent. & Pl. Quar., Washington, D. C.

Garner, J. F., '26. Commercial Beekeeper, Reserve, Kan.

Gilbert, H. W., '31. For Several Years Assist. Ent., Ind. State Board of Agr., Indianapolis, Ind. Now Extension Landscape Gardener, Kansas State College, Manhattan, Kan.

Goodrich, A. L. Graduate Student in Entomology, '34. Assist. Prof. of Zoölogy, Kansas State College, Manhattan, Kan.

Goodwin, Wm. H., '05. For Several Years Assist. Ent., Ohio Agri. Exp. Sta., Wooster, Ohio. Now Supt. of Industrial Education, North Lima, Ohio.

Gui, H. L., '26. Ent., Ohio Agr. Exp. Sta., Wooster, Ohio.

Hall, David G., '29. Assoc. Ent., Bur. of Ent. and Pl. Quar., Washington, D. C.

Hamilton, Clyde Carney, '13. Assoc. Ent., Rutgers College and New Jersey Exp. Sta., New Brunswick, N. J.

Hartwig, Nelle. Instructor in Ent. and Zoöl., Dept. of Ent. and Zoöl., S. D. State College, Brookings, S. D.

Hayes, William Patrick, '13. Assoc. Prof. of Ent., Illinois University, Urbana, Ill.

Hays, J. V., '33. Teacher of Science, Wetmore High School, Wetmore, Kan.

Hollingsworth, H. S. '33. Koscensko, Miss.

Horsfall, W. R. '29. Assist. Prof. of Ent., Brookings, S. D.

Houser, John Samuel, '04. Chief Ent., Ohio Exp. Sta., Wooster, Ohio.

Hoyle, W. L., '37. Principal Bavaria High School, Bavaria, Kan.

Kamal, M., '22. Entomologist, Dept. of Agr., Giza, Egypt.

Keck, C. B., '27. Assist. Ent., Bur. of Ent. and Pl. Quar., Honolulu, Hawaii.

Kelly, Sam G., '30. Junior Ent., Commonwealth of Australia, Uvalde, Tex.

Kent, V. F., '29. Junior Ent., Bur. of Ent. and Pl. Quar. until 1935.

Knaus, Warren, '82. Coleopterist, McPherson, Kan. Deceased.

Kruger, F. S., '33. U. S. D. A. Soil Survey Work, Burlington, Kan.

Lamerson, P. G., '31. Assist. Ent., Kansas. Agr. Exp. Sta., Wathena, Kan.

Lewis, F. C., Major in Ent., '23. Kansas State College, Mansfield, Ill.

Lindquist, A. W., '31. Assoc. Ent., Bur. of Ent. and Pl. Quar., Nico, Cal.

Litwiller, Earl, '25. Formerly Assoc., Prof. of Ent. and Hort., Home Study, Ext. Div., K. S. C., Manhattan, Kan. At present, 1407 North Winter, Salem, Oregon.

McColloch, James Walker, '12. Prof. of Ent., K. S. C. and Assoc. Ent., Kan. Agri. Exp. Sta. Deceased.

McDonald, F. L. Major in Ent., '38. K. S. C., Manhattan, Kan.

McNally, Crystal E., '35. Teacher of Science, Bucklin High School, Bucklin, Kan.

McNay, E. J., Graduate Student, '33. Kansas State College, Manhattan, Kan. At present, Dept. of Ent., Univ. of Cal., Davis, Cal.

Manis, H. C., '36. Graduate Assist., Dept. of Zoöl, and Ent., Iowa State College, Ames, Iowa. June 1, 1938, Research Assist. in the Exp. Sta., Iowa State College.

Marlatt, Chas. L., '84. Retired Chief, Bur. of Ent., Washington, D. C.

Marlatt, Frederick A., '87. For Several Years Assist. Ent., Kan. State Agr. College, Manhattan, Kan.

Marshall, Geo. Edw., '29. Assist. Ent., Indiana Agr. Exp. Sta., Purdue, Univ., Lafayette, Ind.

Maxwell, A. J., Graduate Student, '33. Chetopa, Kan.

Milliken, Francis Burzley, '09. For Several Years Assist. Ent., Bur. of Ent. and Pl. Quar. Present address, 3921A Wayne Ave., Kansas City, Mo.

Munro, J. A., '24. Prof. of Ent. and State Ent., N. D. Agr. College, Fargo, N. D.

Musser, D. R., '33. Rural Rehabilitation Supervisor, U. S. D. A., Atwood, Kan.

Nixon, Ivan L., '03. For Several Years Assist. Ent. of New York. At present Manager of the Instrument Div., Bausch and Lomb Opt. Co., 221 Aldine St., Rochester, N. Y.

Nonamaker, H. L., '33. Rural Rehabilitation Supervisor, U. S. D. A., Smith Center, Kan.

Norton, Jesse Baker, '97. For Several Years Assist. Ent., Kan. Agr. Exp. Sta.; later, Plant Pathologist, Bur. of Pl. Ind. At present, Pl. Breeder, Hartsville, S. C.

Osterberger, B. A., Graduate Student, '37. Asst. Ent., La. Agr. Exp. Sta., Baton Rouge, La.

Park, O. W., '17. Assoc. Prof. of Ent., Iowa State College, Ames, Iowa.

Payne, Nellie, '20. Formerly Assist. Ed., Biological Abstracts, Phil. Pa. At present, Research Ent., Am. Cyanamid Co., Stamford, Conn.

Peairs, Leonard Marion, '05. Prof. of Ent., W. Va. Univ. and Ent. and Vice Director of Agr. Exp. Sta., Morgantown, W. Va.

Popenoe, Charles Holcomb, '05. Assoc. Ent., Bur. of Ent. and Pl. Quar., Washington, D. C. Deceased.

Portman, R. W., Graduate Student, '38. Kansas State College, Manhattan, Kan.

Redding, W. V., '33. Principal of High School, Seagrove, N. C.

Reppert, Ray Ralph, '16. Ext. Ent. of Tex. A. & M. College, College Station, Tex.

Robinson, A. L., Major in Ent., 1936. Assist. in Ent., Commonwealth of Australia, Uvalde, Tex.

Rogers, C. R., '37. Grad. Student in Ent., Antimite Co., Wichita, Kan.

Rowell, J. O., Graduate Student, '33. Ext. Ent., North Carolina State College, Raleigh, N. C.

Rude, Clifford S., '19. Assist. Ent., Bur. of Ent. and Pl. Quar., Tlahualilo, Dgo., Mexico. (In charge of station.)

Sabrosky, Curtis, '33. Instructor in Ent., Dept. of Ent., Mich. State College, East Lansing, Mich.

Schell, Stewart, C., Major in Ent., '38. Kansas State College, Manhattan, Kan.

Schopp, Ralph, '30. Junior Ent., Bur. of Ent. and Pl. Quar., Sumner, Wash.

Schwardt, H. H., '26. Assist. Prof. of Ent., Cornell Univ., Ithaca, N. Y.

Shepherd, B. L., '33. Director of Biology, Tulsa Public Schools, Tulsa, Okla.

Shirck, F. H., '25. Assist. Ent., Bur. of Ent. and Pl. Quar., Parma, Idaho. (In charge of station.)

Smith, Hobart, '32. Major in Ent. in His Undergraduate Work. At present, Chicago Academy of Science, Chicago, Ill.

Smith, W. R., Graduate Student, '34. Rural Rehabilitation Supervisor, U. S. D. A., 1006 Third St., Garden City, Kan.

Snelling, R. O., '33. Agronomist, Univ. of Ill., Urbana, Ill.

Soliman, F. B., '22. Ent., Dept. of Agr., Cairo, Egypt.

Stevens, Orin Alva. '07. Assoc. Prof. of Botany, N. D. Agr. College, Fargo, N. D.

Summerland, S. A., '29. Assist. Ent., Bur. of Ent. and Pl. Quar., Vincennes, Ind.

Taylor, M. M., '30. County Agent, Colby, Kan.

Tuck, J. B., Major in Ent., '38. Kansas State College, Manhattan, Kan.

Turner, A. F., '05. Field Agent, Div. of Extension, Kansas State College, Manhattan, Kan.

Turner, Chester Francis, '12. Formerly Assist. Ent., Bur. of Ent. and Pl. Quar., Washington, D. C. At present, R. F. D. No. 1, Brunswick, Tenn. Farmer.

Valbuena, P. T., Graduate Student, '37. Kansas State College, Manhattan, Kan. At present, Los Angeles, Cal.

Vandenberg, Sidney Randell, '16. Formerly Assoc. Ent., Exp. Sta. of Guam, Island of Guam. At present, 813 South Friends, Whittier, Cal.

Vaughn, Edgar Allen, '12. Commercial Ent., 107 E. LaFayette, Tampa, Fla.

Wadley, Francis Marion, '16. Assoc. Ent., Bur. of Ent. and Pl. Quar., Washington, D. C.

Wagner, Geo. B., '29. Assist. Ent., Bur. of Ent. and Pl. Quar., Manhattan, Kan.

Walker, F. H., '33. Major in Ent., Kansas State College. At present, Salem, Mass.

Walker, H. G., '26. Assoc. Ent., Va. Truck Exp. Sta., Norfolk, Va.

Wassmer, Irene M., Major in Ent., '38. Kansas State College, Manhattan, Kan.

Watson, Shephard Arthur, '20. Head of Dept. of Biology, Whittier College, Whittier, Cal.

Wehrle, Lawrence Paul, '14. Assist. Prof. of Ent., Ariz. Univ., Tuscon, Ariz.

West, Marion C., Major in Ent., '38. Kansas State College, Manhattan.

Whelan, Don B., '14. Assist. Prof. of Ent., Neb. Univ., Lincoln, Neb.

Whitehead, F. E., '24. Assist. Prof. of Ent., Okla. State College, Stillwater, Okla.

Whitehead, Lyndall Porter, '16. For Several Years Assist. Ent., Univ. of Wis., Madison, Wis. At present Dentist, 905 Univ. Ave., Madison, Wis.

Williston, Sameul Wendall, '72. Paleontologist and Dipterist, Chicago University, Chicago, Ill. Deceased.

Wilson, Cecil, '24. Assist. Ent., Bur. of Ent. and Pl. Quar., 600 26th St., Sacramento, Cal.

Winburn, T. F., '31. Captain in the U. S. Army, CCC Camp Commander, Company 1728, Essie, Minn.

Wisecup, C. B., '26. Assist, Ent., Bur. of Ent. and Pl. Quar., Sanford, Fla.

Withington, Charles H., Manual Training and Nature Study in School Work, Cameron, Mo.

Wood, William B., '11. Assoc. Ent., Bur. of Ent. and Pl. Quar., Washington, D. C.

Yapp, R. G., '27. Assist. Ent. Kansas Entomological Commission, Manhattan, Kan.

Yuasa, Hachiro, '15. Prof. of Ent., Kyoto Imperial Univ., Kyoto, Japan for several years. At present, president of Dashiska Univ., Kyoto, Japan.

KANSAS UNIVERSITY STUDENTS

WHO HAVE HELD ENTOMOLOGICAL POSITIONS OR CONTRIBUTED TO ENTOMOLOGICAL LITERATURE*

Adams, C. F., G '03. State Board of Health, Jefferson City, Mo.
Aldrich, J. M., G '93. National Museum, Washington, D. C. (deceased).
Anderson, Lauren D., '30, G '31. Virginia Truck Exp. Sta., Norfolk, Va.
Andrews, Orrel M., G '15. Children's Museum, St. Joseph, Mo.
Baerge, Wm. J., '15. University of Arkansas, Fayetteville, Ark.
Bare, Clarence O., '23, G '24. P. O. Box 415, Charleston, S. C.
Beamer, Raymond H., '13, G '17, Ph D '27. University of Kansas, Lawrence, Kan.
Becton, E. M., '27. Care of W. E. Sexton, Vero Beach, Fla.
Beyer, Adolph H., '12. 109 S. Howard St., Lansing, Mich.
Blackman, M. W., '01, G '02. U. S. National Museum, Washington, D. C.
Branch, Hazel E., '08, G '12. 3756 East Douglas Ave., Wichita, Kan.
Breaky, E. P., '24, G '27. Mellon Institute, Pittsburgh, Pa.
Brennan, James M., G '31. 1010 Travis Building, San Antonio, Tex.
Brown, Barnum, '07. American Museum Natural History, New York City.
Brown, Dudley, '22. Vashon, Washington.
Brown, Wm. F., '14, G '32. Bethel, Kan.
Brown, W. J., '23. Entomological Branch, Dept. Agri., Ottawa, Canada.
Browne, John S., '26. 706 Main St., Santa Ana, Cal.
Bruer, J. Marion, '22, G '23. Macalester College, St. Paul, Minn.
Bunn, Ralph, '30. Bureau Entomology, Federal Bldg., Salt Lake City, Utah.
Butcher, Fred D., '21. 728 8th St. South, Bozeman, Mont.
Butcher, F. Gray, '27. State College Station, Fargo, N. D.
Capps, Hahn W., '29. Nogales, Ariz.
Carpenter, Pearl, '16, G '27. 1724 Massachusetts St., Lawrence, Kan.
Claassen, P. W., '13, G '15. Cornell University, Ithaca, N. Y. (deceased).
Crumb, Ebb S., '08. P. O. Box 233, Puyallup, Wash.
Curran, C. Howard, G '29. Am. Mus. Nat. Hist., 77th St. Central Park West, New York, N. Y.
Darby, Herb, '27. Washington, Kan.
Deal, John, '31, G '31. New York Experiment Station, Riverhead, N. Y.
Deay, Howard, '26, G '27. Purdue University, Lafayette, Ind.
Dews, Sam C., '30, G '32. 231 West 47th Street, Kansas City, Mo.
Doering, Kathleen C., '22, G '23. Dept. Ent., University of Kansas, Lawrence, Kan.
Dorst, Howard E., '29, G '30. U. S. A. C. Campus, Logan, Utah.
Dowell, Allen, G '32. Fayetteville, Ark.
Edmonson, Ellen, '18. 701 E. Austin Street, Marshal, Tex.
Emery, Walter T., '11, G '14. Bur. Ent., U. S. D. A., Manhattan, Kan.
Evans, Neal, G '30. Junior College, Kansas City, Mo.
Fackler, Harry, G '18. 1101 Valley Street, Knoxville, Tenn. (deceased).
Fairbairn, Vera, '27, G '29. (Mrs. Clifford Reusch), Lawrence, Kan.
Fraser, Roy, '14, G '14. 15 Strong Place, Brooklyn, N. Y.
Garlick, W. G. P., G '24. Vineland Station, Ontario, Canada.
Gaumer, Geo. F., '76, G '93 (deceased).

* Prepared by Dr. H. B. Hungerford.

Gilmer, Paul, fs. Bureau Entomology, Tallulah, La.
Gish, Merle L., G '31. 224 W. 1st, Junction City, Kan. (deceased).
Glenn, P. A. '98. Dept. Agri., Univ. of Illinois, Urbana, Ill. (deceased).
Glick, Perry A., fs. '18-'20. U. S. D. A., Exp. Station, Tallulah, La.
Gould, Geo. E., '27, G '29. Purdue University, Lafayette, Ind.
Grady, Howard, '25. Cal. Chemical Spray Co., New York City.
Griffin, Alfred, '11 (deceased).
Hackman, Lucy, '20, G '22. (Mrs. P. A. Readio), Ithaca, N. Y.
Henderson, Lyman S., '33. Dept. of Entomology, University of Kansas, Lawrence, Kan.
Hilkey, Leone, '28, G '29. (Mrs. Harding), Pratsville, Ark.
Hoffman, William E., '18. Lingman University, Canton, China.
Hoffmann, Clarence H., '30, G '31. 8 Whippany Rd., Morristown, N. J.
Hosford, Ruby C., '09, G '13. Care of Mrs. Ralph Oraham, Kaw City, Okla.
Hungerford, H. B., '11, G '13. University of Kansas, Lawrence, Kan.
Hunter, S. J., '93. 1145 West Campus Road, Lawrence, Kan.
Isley, Dwight, G '13. 3 North Duncan Street, Fayetteville, Ark.
Kellogg, Remington, '15, G '16. Smithsonian Institution, Washington, D. C.
Kellogg, Vernon L., '89, G 92. National Research Council, Washington, D. C. (Deceased.)
Lawson, Paul B., G '17, Ph D '19. University of Kansas, Lawrence, Kan.
Liston, Bernard E., '27. 951 Porter Street, Wichita, Kan.
Lockwood, Stewart, fs. Sacramento, Cal.
Lohrenz, H. W., G '11 Bethel College, Newton, Kan.
Malleis, Harry, '23. Care of C. O. Taylor, Belize, British Honduras, Central America.
Mallory, Arthur E., '12, G '23. State Teachers College, Greeley, Colo.
Martin, Charles H. Dept. of Entomology, Cornell University, Ithaca, N. Y.
Mathes, Ralph, '27, G '32. 2462 Parkview Avenue, Toledo, Ohio.
McDaniel, Eugenia, '08. Michigan State College, East Lansing, Mich.
McNeal, Lois C., '30. Duke University, Durham, N. C.
Meek, W. J., '02. University of Wisconsin, Madison, Wis.
Miles, Virgil, '31. U. S. Public Health Service, Savannah, Ga.
Nottingham, John O., '31, G '32. N. Y. College of Agri., Ithaca, N. Y.
Oman, Paul W., '30. Bureau of Entomology, Washington, D. C.
O'Roke, Earl C., '12, G '16. University Michigan, Ann Arbor, Mich.
Palmer, Miriam, '03, G '04. Dept. Ent., Agri. College, Fort Collins, Colo.
Parrott, P. J., '97, G '99. Agri. Exp. Station, Geneva, N. Y.
Peters, Harold, '31, G '32. Sioux Falls, S. D.
Poos, Fred, '15, G '16. Arlington Farm, Rosslyn, Va.
Potter, Glenn J., '27. 310 South Denver, Kansas City, Mo.
Readio, Philip, G '22, Ph D '26. Dept. Ent., Cornell University, Ithaca, N. Y.
Rising, Edna, '21. (Mrs. S. K. Jackson), 204 E. Park Drive, Raleigh, N. C.
Robinson, Wm., G '24. 2401 Calvert St., N. W., Washington, D. C.
Sanborn, Chas. E., G '04. Dept. Ent., A. & M. College, Stillwater, Okla.
Sanderson, Milton, W., '32, G '33, Ph D '37. Univ. of Arkansas, Fayetteville, Ark.
Sellards, E. H., '99, G '00. University of Texas, Austin, Tex.
Scheffer, Theophilus H., '95. 702 Pioneer, Puyallup, Wash.
Schroeder, Herman, '29, G '30. Agri. Exp. Station, Ames, Iowa.

Setty, Laurel, G '30. Park College, Parkville, Mo.

Shaw, J. Gilbert, '30, G '32. Laboratorio Entomologico, Calzada, Mex.

Smith, Ralph H., '16, G '18, Ph D '25. Univ. Cal., Riverside, Cal.

Snow, Francis Huntington (1840-1908). The Founder of Entomological Work at the University and the Author of 60 Papers Relating to Insects.

Snow, W. A., '91, G '94 (deceased).

Spangler, Adolph J., '19. Box 86, Tarleton Station, Stephensville, Tex.

Speery, Charles C., '18. 1441 Welton Ave., Denver, Colo.

Stough, Howard B., G '09. Univ. of Idaho, Moscow, Idaho.

Stugard, Burl, '31. San Juan, Tex.

Sutton, W. S., '1900, G '01. 810 Rialto Bldg., Kansas City, Mo.

Tucker, fs. '91-'02. (Address unknown.)

Tuthill, Leonard D., '29, G '30. Iowa State College, Ames, Iowa.

Vansell, George H., '15. U. S. Pacific Coast Field Station, Davis, Cal.

Weaverling, Helen, '18. (Mrs. C. M. Tapager), Edinburg, Tex.

Weeks, Ella, '01. (Mrs. W. E. Mencher), (Scientific Instructor), Box 308, Lake Worth, Fla.

Wellhouse, Walter H., '13. Iowa State College, Ames, Iowa.

Wiley, Grace Olive, fs. '09-'10. Mus. Pub. Library, 10th and Henepin Ave., Minneapolis, Minn.

Williams, Francis X., '13. Experiment Sta., H. S. P. A., Honolulu, Hawaii.

Wise, Marguerite, E., '01. (Mrs. W. B. Sutton), Box 900, Dallas, Tex.

Withington, Charles H., G '13. 214 W. Cornhill St., Cameron, Mo.

Woke, Paul A., Johns Hopkins University, Baltimore, Md.

Woodruff, Laurence C., '24. Kansas University, Lawrence, Kan.

Young, B. P., '08. 117 Parkway, Ithaca, N. Y.

Botanical Notes, 1937

FRANK U. G. AGRELIUS, Kansas State Teachers College, Emporia, Kan.

A purple lilac was in bloom in Emporia on October 1, 1937. This was the second time for this plant this year.

For the second time, at least, we have noted what is to us a peculiar phenomenon. As a matter of routine, we plant some field corn in one or more flower pots for use in class work. These grow in sand and are watered with tap water. They stand usually in an east window and are kept for some months. For the first time, this year we have given them some commercial fertilizer. The plants reach a height of about one foot. We have never known a tassel to develop, but one or more poorly developed ears have grown on some of the plants. These latter have several husks and a dozen or so silks projecting several inches from the ears.

Throughout the year we have often noted an unusually large number of some kinds of plants. Among these have been the sleepy catchfly (*Silene antirrhina*), wild flax (*Linum sulcatum*), the fairy elm (*Amphiachyris dracunculoides*), the Carolina windflower (*Anemone caroliniana*), a wild lettuce (*Luctuca scariola*), *Gaura biennis* and *Gaura parviflora*, *Chloris verticillata* and *Aster oblongifolius*. A horsemint of uncertain classification, possibly *Monarda pectinata* Nutt., was abundant on rocky prairies in the vicinity of Fall River, Kan.

Of all of these exceptionally numerous plants, Amphiachyris was by far the most abundant. In many places on the prairies it was the only plant visible to the passer-by over thousands of acres.

Several large and seemingly vigorous specimens of two common Tartarian honeysuckles produced what may be truthfully styled loads of brilliant fruit and then proceeded to die almost completely. Some living remnants remain. Our Florence crab fruits alternate years mainly, but does not seem to lack vigor during the intervening nonfruiting years.

Trans. Kansas Acad. Science, Vol. 41, 1938.

Prairie Studies in West-Central Kansas

F. W. ALBERTSON, Fort Hays Kansas State College, Hays, Kan.

Three types of vegetation, with varying degrees of intermixtures, are common in the mixed prairies of West Central Kansas. The shortgrass (*Buchloe-Bouteloua*) type, constituting approximately 30 percent of the remaining prairies, is found widely distributed over the nearly level uplands. Smaller areas and strips also occur at the bases of hills, especially on the south-facing slopes, where the soil is underlaid with a rather impervious clay. The little bluestem (*Andropogon scoparius*) type is most extensive, occupying about 60 percent of the area. This type is generally limited to the hillsides and across shallow ravines. It also extends over the brows of the hills and far beyond where the slopes continue, but gives way rather abruptly to the short grasses on the level uplands. The big-bluestem (*A. furcatus*) type is much more limited in extent, constituting about 10 percent of the prairie. It occupies the deeper ravines and lower parts of gentle slopes.

During the period from 1933 to 1938 the prairies of the Great Plains have been subjected to the worst drought ever recorded. Insufficient soil moisture is a product of several factors. Chief among these factors are decreased rainfall and relative humidity of the air, and increased temperature and wind velocity.

The average annual rainfall at Hays, Kan., for the seventy-year period (1868-1937) is 22.67 inches (table 1). The period of the great drought was preceded by a 6-year wet period when the average annual precipitation was 27.76 inches, or over 5 inches above the 70-year average and about 11.5 inches above the average for the 5-year dry period from 1933 to 1937, which averaged only 16.2 inches annually.

TABLE 1.—Annual rainfall in inches at Hays, Kan.

70-year period, 1868-1937.	Wet period, 1927-'32.	Dry period, 1933-'37.	1933.	1934.	1935.	1936.	1937.
22.67	27.76	16.20	13.48	13.71	19.20	16.46	17.96

The low rainfall during the dry period was accompanied by low relative humidity, high temperature, and high wind velocity. The damaging effect of the low rainfall was further increased by the fact that during July, when soil moisture is most essential to plant growth, precipitation was reduced to less than 30 percent of the 70-year average.

Soil moisture determinations, made in the shortgrass prairie during the growing seasons of 1933 to 1937, indicate that soil moisture was seldom available to plant growth below two feet, and only occasionally in this upper 24 inches. This decrease in available soil moisture, coupled with the increased demands by the environment, resulted in great losses of vegetation.

Overgrazing and blowing of dust from adjacent cultivated fields have ap-

Trans. Kansas Acad. Science, Vol. 41, 1938.

parently contributed largely to the losses that occurred during the 5-year period of drought.

During the past few years an attempt has been made to determine the losses in quantity and quality of vegetation under various conditions. Numerous permanent meter quadrats were staked out and charted in the fall of 1932 and at various times since then. These quadrats represent different types of vegetation under various treatments.

Representative meter quadrats, when heavily grazed and when ungrazed, in a short-grass type, are shown in figures 1 and 2. When there was plenty of moisture, grazing appears not to have reduced the ground cover materially. Under drought, however, the ungrazed vegetation fared much better than the heavily grazed. It is also interesting to note the very definite increase in the number of "weedy" species under heavy grazing. Chief among these are: *Hordeum pusillum, Plantago purshii, Lepidium densiflorum, Hedeoma hispida, Malvastrum coccineum, Gutierrezia sarothrae,* and *Leucelene ericoides.*

During favorable weather conditions such grasses as little bluestem and wire grass (*Aristida purpurea* and *A. longiseta*) invade the short grasses, and in many places take possession.

TABLE 2. Percent ground cover of little bluestem and wire grass among short grasses in spring of 1935 and in fall of 1937.

Kind of grass	*June, 1935*	*October, 1937*
Little bluestem	19.0	Dead
Wire grass	3.0	Dead
Buffalo grass	2.0	2.0
Blue grama grass	9.0	19.0

These scattered bunches of little bluestem and wire grass showed signs of drought injury as early as the very dry year of 1934. In the spring of 1935 meter quadrats were charted showing the distribution of these two grasses among the short grasses. This is shown in table 2. The period of the drought extending from 1934 to 1937 caused an almost total loss of both the less xeric grasses. In fact, the little bluestem was practically all dead by the fall of 1935. Wire grass was able to survive until 1936, and even in 1937 a few small bunches could be found in protected places.

Little bluestem is dominant near the outer edge of the shortgrass habitat. Several meter quadrats were charted on the ecotone between these two types. These quadrats have been ungrazed since 1932. The condition as found in the fall of 1932 and in the fall of 1937 are shown in table 3 and figure 3.

TABLE 3. Percent ground cover in meter quadrat on ecotone between short grasses and little bluestem.

Kind of grass	*June, 1933*	*October, 1937*
Short grasses	6.0	29.0
Little bluestem	65.0	Dead
Tall or sideoats grama	None	3.0

As the drought became more intense the little bluestem and its associates retreated down the hillside and were replaced by the short grasses and tall or side oats grama.

Big bluestem and little bluestem are often in full possession in protected places in the little bluestem habitat on the sides of the hills. When the drought began in 1933, little bluestem was definitely in greater abundance than any of the other grasses. This condition is shown in table 4.

TABLE 4. Percent ground cover of grasses in a meter quadrat of little bluestem type.

Kind of grass	*October, 1932*	*October, 1937*
Little bluestem	72.0	0.4
Big bluestem	18.0	12.0
Tall or sideoats grama	None	8.0
Blue grama	None	2.0

As the drought progressed there were three rather outstanding things that happened: Little bluestem suffered a very severe loss; big bluestem, even though it did not increase the percentage of ground cover, increased its holdings; and tall grama invaded the area.

Heavy grazing, coupled with drought, has had a profound effect upon the kind of grass and the number of forbs in the little-bluestem type. Table 5 gives the species and ground cover of the grasses and also the number of species and total number of plants of the forbs found in little bluestem under ungrazed and heavily grazed conditions.

TABLE 5.—Percent ground cover of grasses and number of species and total number of plants of forbs in an ungrazed and heavily grazed type.

KIND OF PLANTS.	Spring, 1935.		October, 1937.	
	Ungrazed.	Heavily grazed.	Ungrazed.	Heavily grazed.
Little bluestem	35.0	2.0	8.0	1.0
Tall or sideoats grama	3.0	4.0	9.0	5.0
Blue grama	None	6.0	None	10.0
Hairy grama	None	1.0	None	1.0
Wire grass	None	1.0	None	2.0
Number species of forbs	2.0	16.0	8.0	10.0
Total number forbs	8.0	123.0	19.0	61.0

These two quadrats lie across the fence from each other and are representative of the condition where little bluestem is ungrazed and heavily grazed. It is significant that under heavy grazing blue grama replaces little bluestem to a large extent. The number of species of forbs and total number of forb plants are also greatly increased. These plants are mostly of the unpalatable type, such as (Gs) *Gutierrezia sarothrae,* (Pj) *Paronychia jamesii,* (Le) *Leucelene ericoides,* (Lp) *Liatris punctata,* (Gl) *Galpinsia lavandulaefolia,* (Ms) *Meriolix serrulata,* (Pa) *Penstemon albidus,* (Pt) *Psoralea tenuiflora,* (Mc) *Malvastrum coccineum,* (Ep) *Echinacea angustifolia,* (Tr) *Tragia ramosa,* and (Sp) *Senecio plattensis.* This condition is more clearly shown in figure 4.

The blowing of dust from cultivated fields onto the prairie vegetation has, no doubt, caused a decrease in the vegetative cover and also an increase in the number of annual weeds such as the lamb's quarter, pigweed, horse nettle, plantain, etc. A survey was made through southwest Kansas in June, 1937, for the purpose of determining the exact condition of the prairies in that section of the state. Approximately 50-meter quadrats were staked in and charted

with a pantograph. Most of the quadrats had a ground cover between zero and 6 percent. A few, however, contained as much as from 15 to 20 percent.

Vast areas of prairie have been almost completely denuded during the past two or three years. Special study was made of one pasture where the sandy loam soil from an adjacent cultivated field had cut away from one to four inches of the surface soil. Occasionally a tuft of buffalo grass or blue grama grass could be found perched upon a small cone of soil held in place by the roots of the plant. Great drifts of soil were scattered over the "former pasture," where it had accumulated around some old yucca plants or other similar objects. The pastures of this section of the state have probably suffered much more by dust blowing from adjacent cultivated fields than from overgrazing. The two, however, work toward the same end. Figure 5 gives the percent of ground cover in a pasture near Oakley, Kan.

Blowing dust appears to be somewhat more effective in killing out buffalo grass than it is in killing out blue grama grass, but neither grass is able to overcome the smothering effects of this fine soil when once covered by it.

The prairies of West Central Kansas have undergone the greatest change ever witnessed by man and it will doubtless take many years to bring about complete recovery. Vegetation, however, is the product of the sum total of its environmental factors and, as these factors become more conducive for prolific growth, the remnant that remains will gradually restore that which has been lost.

FIGURES 1 AND 2

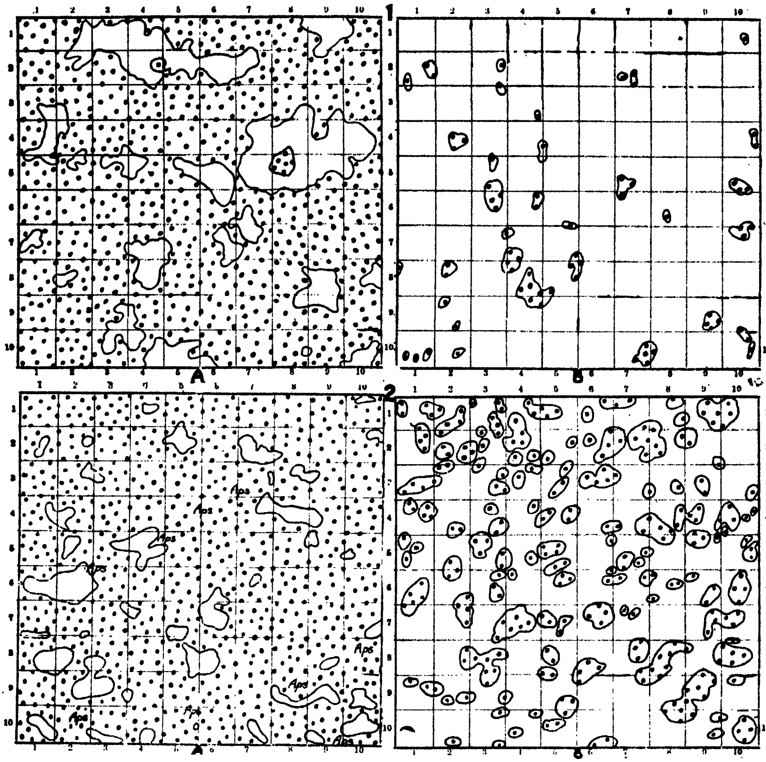


FIG. 1. Meter quadrat, showing basal ground cover of short grasses (stippled) when heavily grazed. (A) Before the drought (82.0 percent), and (B) fall of 1937 (4.0 percent).

FIG. 2. Meter quadrat, showing basal ground cover of short grasses (stippled) when ungrazed. (A) Before the drought (91.0 percent), and (B) fall of 1937 (23.0 percent). (Aps) *Ambrosia psilostachya*.

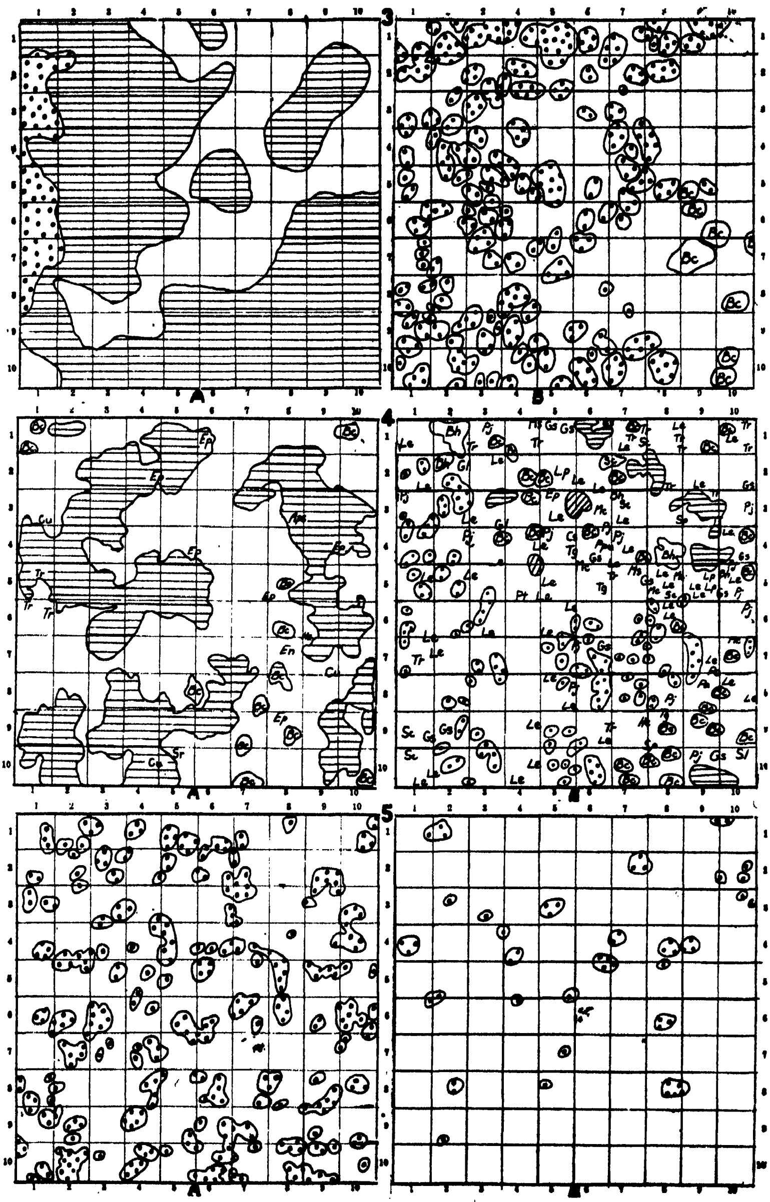
FIGURES 3 TO 5

FIG. 3. Meter quadrat, showing sharp ecotone between short grasses (stippled) and little bluestem (horizontal hatch). (A) Before the drought, and (B) fall of 1937. (Bc) *Bouteloua curtipendula.*

FIG. 4. Meter quadrats, showing the effect of heavy grazing upon little bluestem type. (A) Ungrazed, and (B) heavily grazed. The little bluestem (horizontal hatch) forms large bunches when ungrazed. Under heavy grazing it is largely replaced by short grasses (stippled), wire grass (diagonal hatch), tall grama (Bc), hairy grama (Bh), and various forbs.

FIG. 5. Meter quadrat showing the smothering effect of dust blown from a cultivated field upon the short grasses (stippled). (A) Not near cultivated field, and (B) adjoining cultivated field.

FIGURES 3 TO 5



Studies of a 189-Year-Old American Elm Tree in West-Central Kansas

F. W. ALBERTSON, Fort Hays Kansas State College, Hays, Kan.

One of the largest American elm (*Ulmus americana*) trees observed in this section of the state was removed from the edge of Big creek, near the college buildings on the campus of the Fort Hays Kansas State College, during the fall of 1933. The removal of this tree, along with many other trees and shrubs, was a part of a program in attempting to relieve the flood hazard for the Fort Hays Kansas State College and the city of Hays.

A section of the trunk, taken about five feet above the water in the creek, was polished and preserved for study. Pins were set at intervals of ten annual rings radiating in various directions from the center of the section. As nearly as could be determined, the tree was 189 years old when removed (fig. 1).

The section measured approximately four feet in diameter in an east-to-west direction and about six inches less from north to south.

Three rifle bullets of the type used during the days of the Fort Hays Military Reservation (1865-1889) were found imbedded in the trunk, and also a shallow scar seven inches in diameter filled with shot from a shotgun. It was difficult to determine, due to scar tissue, just when the bullets and shot entered the tree, but all were found near the same annual ring, although in different positions on the circumference of the section. The outside edge of the scars indicated that the bullets and shot entered the tree sometime between 1870 and 1880 and penetrated to a depth somewhat deeper than the ring formed in 1865. A large scar, which appears to have beeen caused by fire, is located in one side of the section. The inner edge of this scar extends into the rings laid down early in the 19th century.

There are two periods in the life of this tree when increased ring width was evident. The first period began about 1754 and the second period began about 1844. This conforms fairly well with the observations made by Dr. E. L. Moseley in Ohio. Whether or not the climatic cycles observed in Ohio extended to this section of Kansas; and further, if they did, just how much effect they might have had on the growth of a tree living on the edge of a stream, would seem somewhat problematical.

Trans. Kansas Acad. Science, Vol. 41, 1938.

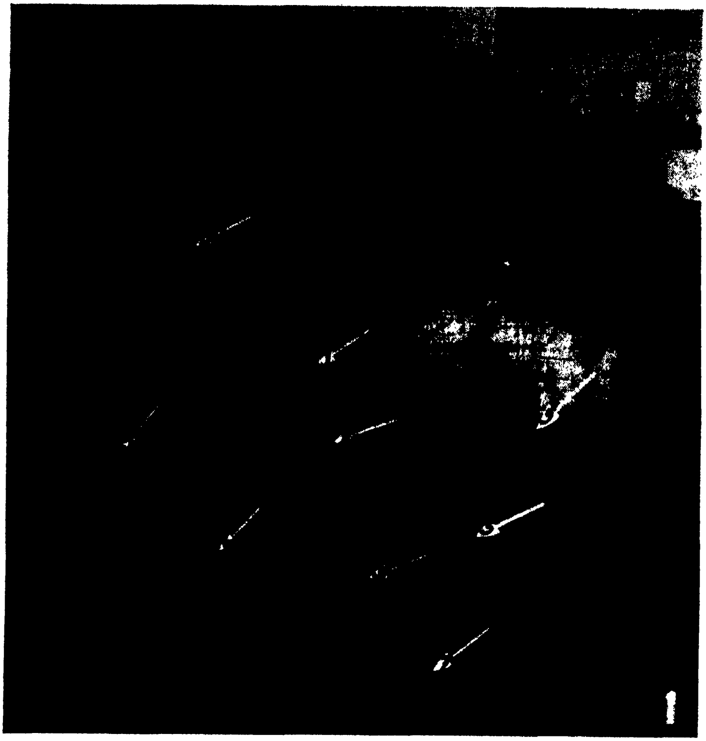


FIG. 1. Photograph of section of trunk taken about 5 feet above the creek level. Numbers from 1 to 7 indicate size of tree when the events listed below occurred: (1) First ring formed 1744; (2) Revolutionary War, 1776; (3) Civil War; (4) burn scar that occurred about 1812; (5) positions from where three bullets were removed; (6) position where numerous shots were found; (7) World War.

An Ecological Study of Wolf's Bog, Cheboygan County, Michigan[1]

RUTH DUTRO, Hagerstown, Ind., and EDITH COHOE, Detroit, Mich.

INTRODUCTION

Wolf's bog has beeen a subject of ecologic interest, because, although it contains the finest example of subclimax Thuja forest in the region, obvious evidence of the beginning of succession to the beach-maple forest, the regional climax, is making headway in it.

LOCATION

Wolf's bog is located in the northern part of sections 13 and 14, Munro township, Cheboygan county, Michigan. It is approximately six miles northeast of the University of Michigan Biological Station, on Douglas Lake. This now lakeless bog covers an area of about 190 acres.

DESCRIPTION

The bog is located in a very evident depression. The last stages of the lake, which was in the northeast edge of the bog, lost its natural vegetation about 1916, when it was transformed into a sawmill pond. When the sawmill was abandoned, vegetation filled in the pond area. At the present time all evidence of this area, with its strictly aquatic plants, has disappeared.

The stream which enters the area at the extreme northeast corner is due to spring floods caused by heavy snows. The stream bed connects with a pond north of the road, and after winding through the climax Thuja it branches to such an extent that its course is extremely hard to follow. These anastomosing branches end in the Salix-Alnus association south of the Thuja. The very evident rise in land at the western and southern boundaries of the bog limit its extent in those directions. Pasture in a cut-over area and a cultivated field also aid in determining the northern boundary. A hardwood forest occupies the ridge on the west, and the Mud Lake Hardwoods connect with the eastern boundary in its central portion.

The land within the bog area has become stabilized. In no place is there found open water surrounded by a quaking mat of vegetation. It follows that only a few species of pioneer bog plants remain, even though there is a great variety of other types of vegetation.

Biotic factors have decidedly influenced the development of Wolf's bog. On the fingerlike projection at the southwestern part of the bog, where Picea is the dominant tree, much second growth Thuja is found. Investigation revealed that a number of Picea trees are being attacked by the mistletoe, *Arceuthobium pusillum*. The presence of dead uncharred Picea indicates the same destruction in the past.

A Larix cemetery of very tall trees is located south of the Picea projection. Since sawfly larvae have destroyed by defoliation most of the Larix trees of

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. The work was done under the direction of Dr. F. C. Gates during the 1936 and 1937 summer sessions of the University of Michigan Biological Station.

this region, it is assumed that such destruction likewise occurred in this particular part of Wolf's bog.

The removal of Christmas trees and extensive lumbering have greatly reduced the number of conifers throughout the entire bog. The lumbering operations which began before the time of the sawmill, first removed great amounts of Thuja, but the more recent lumbering has taken place in the far southwestern part of the Picea projection. Continuation of such lumbering will tend to obliterate this part of the bog forest, because the light conditions of the soil will be different, the effects of wind and precipitation will increase, and the soil structure will change markedly. The existing bog plants, both high and low, will eventually be replaced by the bushes of the adjoining Salix-Alnus associations.

After the trees at the southwestern part had been removed by fire, the owner cut remaining trees and bushes to make pasture. As a result, few species of ground plants occur. Certain grasses with underground rhizomes, such as *Agropyrum repens,* will best bear the pasturing. A new community of weeds, including *Amaranthus graecizans, Chenopodium album* and *Artemisia annua,* has been established in a field adjoining the southeastern corner of the bog.

The pyric factor has been an important one in the development of the bog. The area has been swept by fire at least three times in the past thirty years. The last and most destructive fire occurred in 1918, when most of the southern part of the climax Thuja was destroyed. Many large charred trunks are found throughout the dense growth of Salix and Alnus which now cover the area where greatest destruction took place.

Depths to sand vary in the different associations of the bog, but in no place is there a great accumulation of humus. The lack of water and the shallow basin account for the greater oxidation of vegetation. In the climax Thuja the greatest depth found is 90 centimeters. At a place in the principal east-west path the greatest depth is 60 centimeters. The average depth to sand in the Thuja is 35 centimeters. The other extreme is found on the Prunus ridge, where sand covers approximately ninety percent of the entire surface.

As shown in table No. 1, data taken with a quinhydron electric potentiometer, at the place of greatest accumulation of organic material, show the soil to be alkaline from the surface down about 20 cm., below which the reaction is acid.

TABLE No. 1. The hydrogen ion concentration of the organic soil accumulation at different depths in the Thuja climax Association of Wolf's Bog.

1.	At the surface	pH 7.4
2.	At a 10 cm. depth	pH 7.4
3.	At a 20 cm. depth	pH 7.0
4.	At a 30 cm. depth	pH 6.94
5.	At a 40 cm. depth	pH 6.9
6.	At a 50 cm. depth	pH 6.86
7.	At a 60 cm. depth	pH 6.86
8.	At a 70 cm. depth	pH 6.86
9.	At a 80 cm. depth	pH 6.86
10.	At a 85 cm. depth	pH 6.86

GENERAL DESCRIPTION OF THE VARIOUS ASSOCIATIONS

(1) Thuja Climax

The densest growth of Thuja is found in the lower part of the depression occupied by the bog. Many years ago the Thuja forest covered a much larger area. Thuja stumps and fallen logs of great circumference are found in all of the bog subareas except that dominated by *Prunus pennsylvanica*. This forest contains the largest Thuja ever found in the Douglas Lake region. Their diameters range from 60 centimeters to a meter, and the age of one of the largest is estimated to have been approximately four hundred years.

In a count of mature trees the following approximate percentages of species were found: *Thuja occidentalis*, 62; *Tsuga canadensis*, 18; *Acer rubrum*, 14; *Abies balsamea*, 2; *Betula papyrifera* 2; *Sorbus americana*, 2. Results obtained from field work carried on in 1937 shows that this climax Thuja is not going to be replaced by young Thuja and is therefore entering into a stage of succession. In a series of seven-point observation areas, each consisting of twenty square meters, interesting data concerning comparative density of deciduous and coniferous seedlings were observed. In the dense Thuja areas the average density (ground coverage) of seedlings of deciduous trees was over nine times that of seedlings of conifers. (See table No. 2.) This large number of deciduous seedlings and saplings, taken with their healthy condition, is the best evidence of the onset of succession.

The greater part of the bog area is flooded in the spring, and evidences show that this is particularly true in this Thuja subarea. The ground surface is covered with hummocks, and the tree needles on its surface are cemented together into huge masses. The presence of *Typha latifolia* and many species of Carex are indicatory of this. The fallen logs on which luxuriant growths of mosses occur could hardly have obtained their ample supply of moisture in any way except through flooding.

Very little ground vegetation is found within the forest because of the deep shade cast by the larger Thuja. The greatest amount of ground vegetation is found in the lumbering paths and along the stream bed. The species found most commonly with the Thuja here include: *Coptis trifolia, Galium triflorum, Mitella nuda, Rubus triflorus, Maianthemum canadense, Viola pallens, Trillium grandiflorum, Arisaema triphyllum*, and *Aspidium thelypteris*. The grass found most abundantly in this region is *Brachyelytrum erectum*.

(2) Picea-Abies Association

The association dominated by Picea and Abies is found in the projection located southwest of the cilmax Thuja. The Thuja here are not as large nor as abundant as in the first area.

Work carried on in 1937 shows that in this area there are very many more coniferous seedlings than deciduous. It is concluded that this is the part of the bog in which most growth toward the typical high bog forest is taking place.

The ground vegetation is made up of a greater number of species than that of the Thuja climax. The explanation is that the ground is not so densely shaded by the smaller Picea and Abies, and that more moisture is retained

TABLE 2.—Point observation data, showing the density of vegetation at different levels (quadrats each two square meters in area; full coverage expressed as 100).

AREA I.—CLIMAX THUJA.

QUADRAT	1	2	3	4	5	6	7	8	9	10	Total density.
Levels of Plant Growth.											
Trees	100	75	80	80	65	100	100	100	80	100	880
High shrubs	0	1	0	0	12	0	10	2	0	0	25
Low shrubs	40	2	7	15	25	40	5	10	2.5	2.5	149
Ground cover	1.3	3.8	5.4	2.3	2.5	1.8	4.6	5.5	4.6	6.3	38.1
Tree trunks	5	3	2	4	6	10	7	10	6	8	61
Seedling conifers	0	0	0	0	0	0	0	0	.3	0	.3
Seedling deciduous trees	0	0	.8	.5	.3	0	.3	.5	.3	.3	3.0
Seedling shrubs	.3	0	.3	.3	.3	0	.3	0	0	0	1.5
Grasses and sedges	0	.3	0	0	.3	.3	0	0	0	0	0.9
Forbs	1	.5	.3	0	.3	.5	1	3	1	5	12.6
Moss cover	0	3	4	1.5	1.3	1	3	2	3	1	19.8

AREA II.—PICEA-ABIES PPOTECTION.

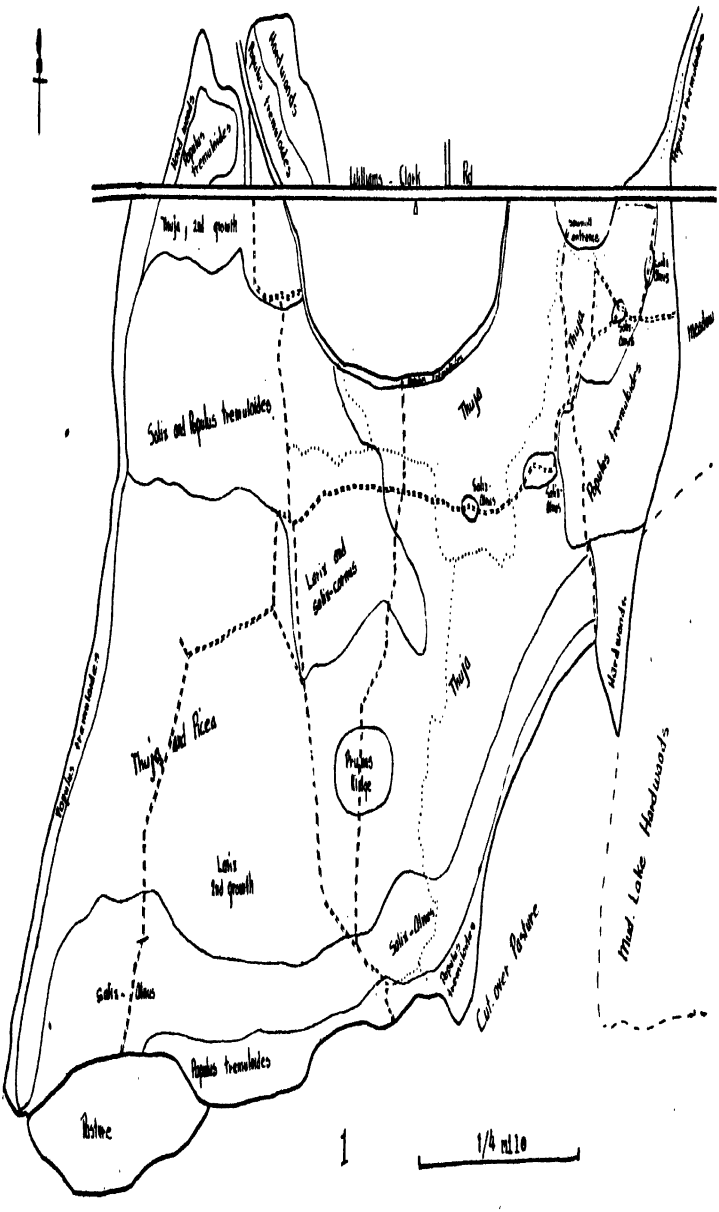
QUADRAT	1	2	3	4	5	6	7	8	9	10	Total density.
Levels of plant growth.											
Trees	10	100	50	90	80	0	50	100	100	100	680
High shrubs	30	10	0	10	0	80	50	10	10	0	200
Low shrubs	50	25	75	60	22	50	28	100	100	10	520
Ground cover	19	3.3	12.3	1.6	9.5	7.6	4.8	1.3	3.8	18.4	81.6
Tree trunks	1	10	3	7	9	1	2	1.5	4	2	40.5
Seedling conifers	4	.3	.3	.8	.5	.3	.8	.8	.3	.4	8.5
Seedling deciduous trees	0	0	0	0	0	.3	0	0	0	0	0.3
Grasses and sedges	3	0	8	.3	5	2	2	0	0	4	24.3
Forbs	2	1	1	.5	3	1	2	.5	.5	10	21.5
Mosses	10	2	3	0	1	4	0	0	3	4	27.0

in the ground because of the large quantities of Sphagnum. It is in the paths of this moist area that the rare bog plants are found. Examples of such plants are; *Drosera rotundifolia, Cypripedium parviflorum, Cypripedium reginae, Arethusa bulbosa, Listera convallarioides* and *Spiranthes romanzoffiana.*

(3) LARIX ASSOCIATION

The Larix in Wolf's bog is second growth, and has developed since the devastating work of the sawfly larvae in 1916-1918. However, much of the first growth may have been removed by fire, for there are many charred stumps. Larix trees are very shallow rooted, and the loss from windfall may have been great. Only one of the first growth Larix trees remains in this central part. The age of the younger trees averages twenty-five years.

The shrub and tree count showed the following approximate percentages of species; : *Larix laricina,* 60; *Populus tremuloides,* 14; *Salix* spp, 10; *Picea mariana,* 6; *Thuja occidentalis,* 6; *Cornus stolonifera,* 2; *Populus balsamifera,* 2. One characteristic of this association is the presence of a great quantity of shrubs and a dense ground cover of a great variety of species. Species of ground vegetation which occur most frequently are: *Botrychium virginianum, Chiogenes hispidula, Cypripedium parviflorum, Eriophorum viridi-carinatum, Vaccinium oxycoccus, Lycopus americanus, Rubus triflorus, Fragaria virginiana.*



Map 1. Wolf's bog, showing the present-day associations

South of the Picea-Abies projection is a long narrow area which contains many extremely tall dead Larix trunks. All the older living Larix have disappeared. Their destruction has probably been caused by the sawfly larvae. A very dense growth of small Larix is found here. The size of these trees indicate an approximate age of twenty years. These young trees take so much of the ground space that there is little left for other vegetation. This zone gradually changes into a high bog shrub association dominated by *Salix* spp. and *Alnus incana.*

(4) Salix-Alnus High Bog Shrub Association

The high bog shrub association in the area is dominated by *Alnus incana* and various species of Salix. It is found in the eastern part of the bog, south and east of the climax Thuja, and again south of the Piceas-Abies finger. There is also an extensive area south of the Larix cemetery; this forms an irregular zone paralleling the southern boundary, but in most cases separated from it by an area dominated by *Populus tremuloides.*

Where the Salix-Alnus occurs in the eastern part of the bog, two other associations are found quite generally mixed with it. In the more northerly part is much *Populus tremuloides,* and *Larix laricina* is found in the southerly section. Furthermore, charred logs and invading conifers indicate that this particular part of the association is very unstable.

At this place there is a tendency for *Cornus stolonifera* to replace Alnus as a dominant with the Salix. The shrubs are low; there is abundant sunlight, and a considerable Sphagnum mat to retain the moisture. Such soil and light conditions are conducive to a great variety of species. The close contact with neighboring associations greatly increases that number.

South of the Picea-Abies projection and south of the Larix cemetery the shrubs form such dense clumps that passage through this area is very difficult. Many small trees of Picea, Larix and Thuja are present. The Salix and Alnus are taller than those in the part of the association discussed above, and so close together that the ground is densely shaded. The straggly appearance of the ground plants indicates the need for more light, if they are to survive.

A count of trees and shrubs showed the following approximate percentages: *Alnus incana,* 50; *Salix* sp., 34; *Betula papyrifera,* 10; *Abies balsamea,* 4; *Populus tremuloides,* 2. The following species of ground plants found quite generally are: *Typha latifolia, Maianthemum canadense, Fragaria virginiana, Eupatorium purpureum, Cirsium arvense, Solidago* sp., *Aralia nudicaulis, Viola canadensis, Coptis trifolia, Clintonia borealis, Ledum groenlandicum, Eriophorum viridi-carinatum* and *Rubus strigosus.*

(5) Populus Tremuloides Association

Associations in which *Populus tremuloides* dominates are found irregularly distributed within the bog. The part of the *Populus tremuloides* adjoining the northern climax Thuja and extending to the meadow on the east is the most representative. The charred and cut logs show this to be a secondary association caused by the destruction of fire and lumbering in a Thuja association. The disturbing factor evidently ended suddenly, for just across the path from the northern edge of the *Populus tremuloides* is the old climax Thuja association.

The trees at this particular place, as is true of the aspens in Wolf's bog, are medium sized or small. A tree count gives the following approximate percentages: *Salix* spp., 40; *Populus tremuloides*, 36; *Betula papyrifera*, 12; *Alnus incana*, 4; *Picea mariana*, 4; *Abies balsamea* 2; *Acer rubrum*, 2.

The invasion of the area by the Mud Lake hardwoods from the south and east is shown by an increasing number of seedlings and saplings of *Acer saccharum* and *Tilia americana*. Then coniferous seedlings and saplings from the Thuja association at the north and west have also invaded this area. In addition to the invading plants from these two associations, there are also invaders from the Salix-Alnus association and from the nearby pasture. The ground vegetation consequently includes a mixture of species, including: *Pteris aquilina, Hieracium aurantiacum, Epilobium angustifolium, Aralia nudicaulis, Lactuca canadensis, Trifolium repens, Fragaria virginiana, Gaultheria procumbens, Achillea millefolium,* and *Rumex acetosella*.

(6) Prunus Pennsylvanica Association

The prunus association is located on an oval shaped sandy east-west ridge about 400 meters wide and 900 meters long. Its presence is due to glacial deposition. The presence of charred logs indicates that it did not escape the ravages of fire.

The small amount of ground vegetation supported by the sandy soil is stunted or dying. None of the prunus trees exceed a height of 10 meters. A tree count gives the following approximate percentages: *Prunus pennsylvanica*, 86; *Acer rubrum*, 12; *Picea mariana*, 2. The following ground plants are found: *Epilobium angustifolium, Fragaria virginiana, Phleum pratense, Diervilla lonicera, Hieracium aurantiacum, Verbascum thapsus* and *Pteris aquilina*. Mosses of the genera Ceratodon and Polytrichum form a brownish cover over much of the ground surface.

There seems to be an invasion from the west of young Larix and *Picea mariana*, but their growth will probably be not extensive because of the elevation of the area.

SUMMARY

1. Wolf's bog, a tree-covered lakeless area in Cheboygan county, Michigan, exhibits six types of vegetation: (1) Thuja, the climax forest, found in the deepest part of the depression; (2) Picea-Abies, which extends over a slightly higher area; (3) Larix, which forms a second growth area where the plant successions have been most disturbed; (4) High bog shrub, dominated by Salix and Alnus, which forms an intermedial zone between the *Populus tremuloides* area and the Thuja; (5) *Populus tremuloides*, on the clayey elevations; (6) *Prunus pennsylvanica*, on a sandy ridge.

2. Fires have swept over parts of the area several times in the last thirty years. Lumbering, attacks of the sawfly larvae, and the growth of the mistletoe, *Arceuthobium pusillum*, are important factors in producing the present stage of bog development in the area studied.

3. Approximately 270 species of plants, representing 54 families of Spermatophytes, 3 of Pteridophytes and 18 of Bryophytes, have been collected.

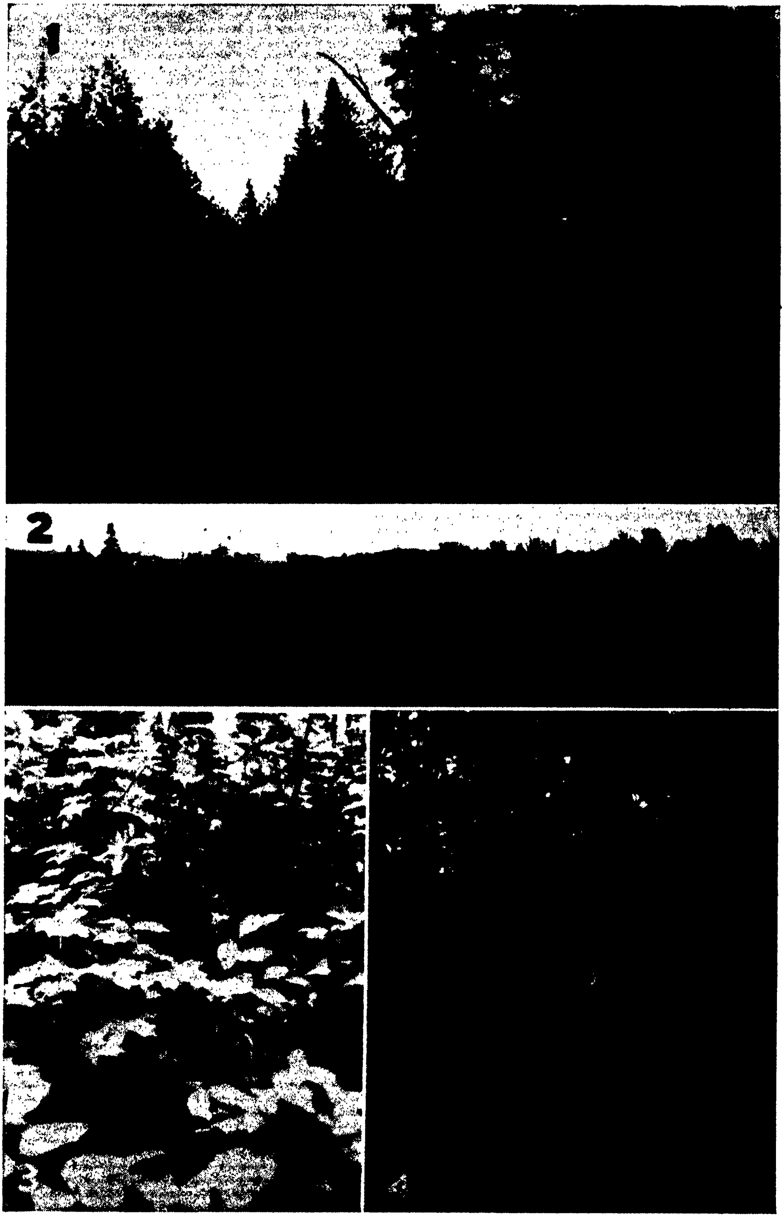
4. It seems evident from the appearance of many seedlings, saplings and occasional tree representatives of the beech-maple plant association within the climax Thuja that the successional tendency is toward the beech-maple forest.

VIEWS OF WOLF'S BOG

FIG. 1. Characteristic vegetation at northeast entrance.
FIG. 2. General view from the northward.
FIG. 3. Invasion of beech-maple elements into the Thuja association
FIG. 4. A dense part of the Thuja association.

(Photos by Elsie Townsend, G. S. Avery and W. H. Stickel.)

VIEWS OF WOLF'S BOG



Views of Wolf's Bog

Kansas Botanical Notes, 1937[1]

FRANK C. GATES, Kansas State College, Manhattan, Kan.

The year 1937 was outstanding for its late spring. A severe ice storm late in the winter left ice on the ground for a long time. Many of the phenological records were from two to four weeks later than we had previously recorded. The season did not catch up until late in May.

Among the noteworthy botanical events of the spring were the large numbers of mustards, particularly *Sophia intermedia, Capsella bursapastoris* and *Thlaspi arvense,* which were extraordinarily abundant, covering many fields and making some express fear of danger from them; the appearance of flowers for the second time on the Ginkgo trees on the Kansas State College campus; a plant of *Penstemon cobaea* with whorled leaves; and *Oxalis violacea* with few and very late flowers. Evidently the extraordinary abundance of late flowers of this oxalis in the fall of 1936 had used up the reserves.

Seeds of *Ulmus americana* were extraordinarily abundant this spring, while in *Acer saccharinum* seeds were few. The Acer had come into bloom just ahead of the ice storm, while the Ulmus did not blossom until very late.

Robinia hispida, a small tree on the Kansas State College campus, was found to have a completely twinned pistil.

Amphiachyris draeunculoides, which has been spreading extensively in recent years in eastern Kansas, made the jump to Sheridan county this past year. It is not quite so abundant in the vicinity of Manhattan, however, as it was last year.

As was to be expected, many trees died from the continued drought. Numerous dead Osage oranges (*Maclura pomifera*) in central Kansas were the most surprising.

As a result of a survey by the Soil Conservation Service, red cedar (*Juniperus virginiana*), Chinese elm (*Ulmus pumila*), and Osage orange (*Maclura pomifera*) are the best trees suited for the semiarid conditions of western Kansas. A count was made of tree plantings of all common species, many of which are more than thirty years old, in southwest Kansas and the panhandle region of Oklahoma and Texas and southeast Colorado. Out of 6,500 counted, the percentage of survival of those alive in 1937 was found to be black locust 67 percent, Osage orange 85, red cedar 93, Chinese elm 87, ash 5, mulberry 42, thorny locust (honey locust) 48, black walnut 18, and seedling apricot 7.

An unusual case of a natural cross between a cultivated plant and a wild species has beeen brought to my attention by C. O. Johnston. Atlas sorgo, a juicy silage-type sorghum with a grain-sorghum head, is much sought after because of its good quality. During the extraordinarily dry years of 1936 and 1937 the principal source of large quantities of Atlas seed in Kansas was the irrigated properties of the Robbins ranch near Belvedere, Kan. The banks of the irrigation ditch were lined with Johnson grass, a grass with large panicle and well-developed perennial rhizomes. Here and there in the seed beds and

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Contribution No. 380, Department of Botany and Plant Pathology.

later in properties which had planted seed from this ranch, appeared tall, vigorous hybrids. This is the characteristic vigor of F_1 sorghum plants, but in this case, one parent was the Johnson grass. Interspecific hybrids from controlled crossing of native or wild plants with cultivated sorghums have been regularly sterile, but it is noteworthy that here many fertile seeds were produced. The hybrid plants had characteristic Johnson grass rhizomes, which, however, exhibited many degrees of length. The panicles were more typical of Johnson grass than the regular Atlas sorgo. It is not yet known whether this hybrid will maintain itself, or whether it will run back to one or the other of the parents.

In the fall of 1937 there was an extraordinarily large number of fruits on trees of *Celtis occidentalis* and *Juniperus virginiana*. Among the unusual plants of Kansas, a second collecting of *Agrostis elliottiana* in Crawford county by Clyde L. Merritt should be mentioned.

During the year the work on the state herbarium continued, with the completion of state maps of distribution in Kansas herbaria. Efforts to track down references in the literature to definite specimens has resulted in a small number being found, mostly in the National Herbarium at the Smithsonian Institution. During the year the few additions made to the Kansas Herbarium include principally those of Nellie B. Jacobs from Cherokee and Crawford counties, Clyde L. Merritt from Crawford county, Anna Steller from Cheyenne county, and F. C. Gates from Geary and Linn counties.

Woody Plants, Native and Naturalized in Kansas [1]

FRANK C. GATES, Kansas State College, Manhattan, Kan.

In response to repeated requests for an up-to-date list of the trees in Kansas to replace that in a bulletin on *Trees in Kansas,* now out of print, it was thought worth while to make this list cover all of the woody plants, trees, shrubs and lianas. This list will bring the tree list up to date, but will not be supported by descriptions, keys, or drawings. In this list, no attempt is made to include occasional escapes, nor to include woody plants which have been credited to Kansas in various manuals, but for which no herbarium specimens have been located. Also, several plants that are woody at the base only, and whose tops die down to or near the ground, such as certain species of Clematis, are not considered as woody plants within the definition of this list. The 225 species, varieties and hybrids of the list are grouped under 45 families. Of this 225, the native flora contains 107 kinds of trees, 80 kinds of shrubs and 20 lianas. Each scientific name is accompanied by the recognized common name, following the Forest Service wherever possible. This is followed by a general statement of the growth form (whether tree, shrub, or liana), often by a soil preference, and, finally, a general statement of distribution. The distribution is expressed ordinarily on the basis of thirds or sixths of the state, while counties are given only in case the plant occurs in but one or two counties. The distribution also is shown on maps in which a solid dot indicates a specimen in the Kansas State Herbarium at Manhattan; a ring, a specimen in some other herbarium; a C that the plant was cultivated, and an X, a record by some responsible person, unsupported, however, by a specimen. These plants are considered as native plants unless otherwise stated.

A few woody plants have been credited to the state in various manuals, but in the apparent absence of specimens should be excluded, viz., *Pinus echinata* is credited with having been in the southeastern corner of the state, but no herbarium specimens have been found and no collector within the past seventy-five years has been able to find a specimen. Indeed, Prof. E. J. Palmer at different times, and myself twice, have made efforts to locate such a specimen, but without success. *Ulmus alata* is cultivated in a few places in the state, but as far as we know, a tree about six miles south of the Kansas border in northeastern Oklahoma is the closest it gets.

Others include: *Juglans cinerea* L., *Vaccinium canadense* Kalm., *Bumelia lycioides* (L.) Pers., *Spiraea salicifolia* L., *Spiraea tomentosa* L., *Malus angustifolia* Ait. (=*M. lancifolia* Rehder), *Rhamnus caroliniana* Walt., *Rubus hispidus* L., and *Vitis rotundifolia* Michx.

While woody plants are distributed throughout the state, in general they do not dominate the native vegetation. On the uplands trees occur naturally only in the eastern fifth or sixth. Westward, grass associations dominate the uplands. Trees, however, continue along the streams quite generally in the eastern third to half of the state. They extend farther west in the northern part of the state, but occasional representatives may be found even in the southwestern

---

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Contribution No. 881, Department of Botany and Plant Pathology.

part. Shrubs exceed these limits, as might be expected, but still do not qualify as a real chaparral vegetation type. For the most part shrubs occur in land that, barring adverse factors, could support trees, or are a transitional fringe (ecotone) between forest and grassland. Lianas are not independent of either trees or shrubs, but are more frequently found associated with trees.

The maps were made by Laura Herr, an NYA student.

LIST OF NATIVE AND NATURALIZED WOODY PLANTS OF KANSAS

PINACEAE. Pine Family

Juniperus virginiana L. Red Cedar. Upland tree nearly throughout (map 1).
Pinus spp. Several species planted, rarely escaping.

LILIACEAE. Lily Family

Smilax bona-nox L. Smilax. Liana, southeast (map 2).
Smilax hispida Muhl. Smilax, greenbrier. Liana in east two thirds (map 3).
Smilax pseudo-china L. Smilax. Liana, scattered in east third (map 4).
Smilax rotundifolia L. Smilax. Liana in east sixth (map 5).
Yucca glauca Nutt. Yucca, soapweed, beargrass. Shrub in west three fourths (map 6).

ANONACEAE. Custard Apple Family

Asimina triloba (L.) Dunal. Papaw. Small tree in east third (map 7).

LAURACEAE. Laural Family

Benzoin aestivale (L.) Nees. Spicebrush. Shrub in southeast three counties (map 8).
Sassafras variifolium (Salisb.) Kuntze. Sassafras. Shrub in extreme southeast (map 9).

TILIACEAE. Linden or Basswood Family

Tilia americana L. (*T. glabra* Vent.) Basswood. Tree in east half (map 10).
Tilia palmeri Bush. Basswood. Tree in central part of east fourth (map 11).

ULMACEAE. Elm Family

Celtis laevigata Willd. Mississippi hackberry, sugarberry. Tree in southeast (map 12).
Celtis laevigata texana (Scheele) Sarg. Mississippi hackberry, sugarberry. Tree in Cowley county (map 13).
Celtis occidentalis L. Hackberry. Low and upland. Tree in east five sixths (map 14).
Celtis occidentalis canina (Raf.) Sarg. Hackberry. Tree in east (map 15).
Celtis occidentalis crassifolia (Lam.) Gray. Hackberry. Tree, except the southwest sixth (map 16).
Celtis pumila Pursh. Dwarf hackberry. Small tree in Riley county (map 17).
Celtis reticulata Torr. Hackberry, Palo blanco. Small tree in west half (map 18).
Celtis rugulosa Rydb. Hackberry. Small tree in west half (map 19).
Ulmus americana L. American elm. Lowland tree, throughout except southwest sixth (map 20).

Ulmus fulva Michx. Slippery elm. Tree, north third plus east half (map 21).
Ulmus pumila L. Chinese elm. Tree much planted and escaped.
Ulmus racemosa Thomas. Rock elm. Tree in east half (map 22).

MORACEAE. Mulberry Family

Maclusa pomifera (Raf.) Schneider. Osage orange. Small tree, planted in east three fifths, freely escaping. Credited as native in extreme southeast (map 23).
Morus alba L. White mulberry. Tree, escaped nearly throughout (map 24).
Morus nigra L. Black mulberry. Tree, escaped in central (map 25).
Morus rubra L. Red mulberry. Tree in east three fifths (map 26).

RUTACEAE. Rue Family

Ptelea trifoliata L. Hoptree. Small tree in east third (map 27).
Zanthoxylum americanum Mill. Pricklyash. Small tree in east half (map 28).

SIMARUBACEAE. Quassia Family

Ailanthus altissima (Miller) Swingle. Ailanthus, tree of heaven. Tree escaped mostly in northeast fourth (map 29).

HYPERICACEAE. St. John's-Wort Family

Ascyrum hypericoides L. St. Andrew's cross. Shrub in extreme southeast (map 30).

TAMARICACEAE. Tamarix Family

Tamarix gallica L. Tamarisk. Recently escaped large shrub, scattered in west two thirds, mostly on sand bars (map 31).

SALICACEAE. Willow Family

Populus alba L. White or silver poplar. Tree escaped (map 32).
Populus sargentii Dode. Plains cottonwood. Tree in west two thirds (map 33).
Populus virginiana Fourg. Cottonwood. Tree throughout, especially eastern (map 34).
Populus virginiana pilosa (Sarg.) Cottonwood. Tree, eastern.
Salix[2] alba L. White willow. Cultivated, seldom escaping (Shawnee county).
Salix amygdaloides Anders. Peachleaved willow. Small tree throughout (map 35).
× Salix amygdaloides × nigra Glatf. Willow. Tree in central.
Salix amygdaloides wrightii (Anders.) Schn. Wright willow. Small tree in southwest (map 36).
Salix babylonica L. Weeping willow. Tree, mostly cultivated (map 37).
Salix cordata Muhl. Diamond willow. Shrub in central (map 38).
Salix exigua luteosericea (Rydb.) Sandbar willow. Shrub in west fourth to Sedgwick county (map 39).
Salix fragilis L. Crack willow. Tree, escaped in east half (map 40).
Salix humilis rigidiuscula. Prairie willow. Shrub in west half (map 41).
Salix interior Rowlee. Sandbar willow. Tree throughout (map 42).
Salix interior pedicellata. Sandbar willow. Shrub, scattered (map 43).

2. The willows checked by C. R. Ball.

Salix longipes wardii (Bebb.) Schn. Ward willow. Small tree scattered in south two thirds of east two thirds (map 44).
Salix missouriensis Bebb. Missouri willow. Tree in east two thirds (map 45).
Salix nigra Marsh. Black willow. Tree in southeast half (map 46).
Salix tristis Ait. Willow. Shrub scattered in east half (map 47).

ERICACEAE. Heath Family

Vaccinium arboreum Marsh. Farkleberry, tree huckleberry. Shrub in extreme southeast (map 48).
Vaccinium stamineum L. Squaw huckleberry. Shrub in extreme southeast (map 49).
Vaccinium stamineum neglectum (Fern.). Blueberry, tree huckleberry. Shrub in extreme southeast (map 50).
Vaccinium vacillans Kalm. Blueberry. Shrub in extreme southeast (map 51).

SAPOTACEAE. Sapodilla Family.

Bumelia lanuginosa (Michx.) Pers. Woolly buckthorn, gum elastic. Small tree in southeast (Linn to Harper counties) (map 52).

EBENACEAE. Ebony Family

Diospyros virginiana L. Persimmon. Tree native in south half of east third (map 53).
Diospyros virginiana platycarpa Sarg. Fide Sudworth.

SOLANACEAE. Potato Family

Lycium halimifolium Mill. Matrimony vine. Shrub or liana, escaped especially in the north (map 54).

OLEACEAE. Olive Family

Forestiera acuminata (Michx.) Poir. Swamp privet. Shrub in extreme southeast (map 55).
Fraxinus americana L. White ash. Tree in east fourth (map 56).
Fraxinus pennsylvanica Marsh. Red ash. Tree in east four fifths (map 57).
Fraxinus pennsylvanica campestris (Britton). Prairie ash. Tree except in southwest ninth, commoner westward (map 58).
Fraxinus pennsylvanica lanceolata (Borkh.) Sarg. Green ash. Tree throughout southwest (map 59).
Fraxinus quadrangulata Michx. Blue ash. Tree native in southeast twelfth (map 60).

BIGNONIACEAE. Trumpet Creeper Family

Campsis radicans (L.) Seem. Trumpet creeper. Liana in southeast, escaping northward (map 61).
Catalpa speciosa Warder. Hardy catalpa. Tree, escaping in east half (map 62).

ROSACEAE. Rose Family.

Cercocarpus montanus Raf. Mountain mahogany. Shrub in northwest (map 63).
Rosa arkansana Porter. Rose. Shrub in southwest (map 64).
Rosa blanda Ait. Rose. Shrub in east half (map 65).

Rosa carolina L. Rose. Shrub in extreme southeast (map 66).
Rosa conjuncta Rydb. Rose. Shrub in extreme east (map 67).
Rosa lyoni Pursh. Rose. Shrub in extreme southeast (map 68).
Rosa rubifolia R. Br. Rose. Shrub in east third (map 69).
Rosa rubiginosa L. Rose. Shrub in northeast fourth (map 70).
Rosa serrulata Raf. Rose. Shrub in southwest (map 71).
Rosa setigera Michx. Rose. Shrub in east seventh (map 72).
Rosa suffulta Greene. Rose. Shrub throughout (map 73).
Rosa woodsii Lindl. Rose. Shrub in extreme west (map 74).
Rubus flagellaris Willd. Blackberry. Shrub in east third (map 75).
Rubus flagellaris occidentalis Bailey. Blackberry. Shrub in central (map 76).
Rubus laudatus Berger. Blackberry. Shrub in central (map 77).
Rubus nigrobaccus Bailey. Blackberry. Shrub in east (map 78).
Rubus occidentalis L. Black raspberry. Shrub in east half (map 79).
Rubus ostryifolius Rydb. Highbush blackberry. Shrub in east two thirds but mostly east third (map 80).

MALACEAE. Apple Family

Amelancheir canadensis (L.) Medic. Serviceberry, juneberry. Small tree in east fourth (map 81).
Amelanchier humilis Wieg. Serviceberry. Shrub in southeast.
Amelanchier laevis Wieg. Serviceberry. Small tree in east seventh (map 82).
Crataegus[3] calpodendron (Ehrh.) Medic. Thornapple. Small tree in east fourth (map 83).
Crataegus calpodendron hispidula (Sarg.) Palmer. (*C. hispidula* Sarg., *C. spinulosa* Sarg.). Cherokee county (map 84).
Crataegus calpodendron obesa (Ashe) Palmer. (*C. globosa* Sarg.) Small tree in east fourth (map 85).
Crataegus coccinioides Ashe. (*C. speciosa* Sarg.) Cherokee county. East (map 86).
Crafaegus collina Ell. (*C. macropoda* Sarg., *C. vicina* Sarg.) Cherokee, Crawford counties (map 87).
Crataegus crusgalli L. (*C. arduennae* Sarg., *C. ferox* Sarg., *C. strongylophylla* Sarg.) Cherokee county. East fourth (map 88).
Crataegus discolor Sarg. (*C. rubrifolia* Sarg.) Cherokee, Franklin counties (map 89.)
Crataegus engelmanni Sarg. (*C. munita* Sarg.) Cherokee county (map 90).
Crataegus lanuginosa Sarg. (*C. dasyphylla* Sarg.) Cherokee county (map 91).
Crataegus mackenzii bracteata (Sarg.). Palmer. (*C. bracteata* Sarg.) Cherokee county (map 92).
Crataegus mollis (T. & G.) Scheele. (*C. lasiantha* Sarg.) Crawford, Wilson, Franklin counties. East third (map 93).
Crataegus palmeri Sarg. Cherokee county (map 94).
Crataegus regalis paradoxa (Sarg.) Palmer. (*C. paradoxa* Sarg.) Cherokee county (map 95).
Crataegus stevensiana Sarg. Wilson county (map 96).

3. Definite county records given here were kindly furnished by E. J. Palmer of the Arnold Arboretum. All species of Crataegus in Kansas are small trees.

Crataegus succulenta Schrad. (*C. neofluvialis* Ashe.) Small tree scattered (map 97).

Crataegus succulenta pertomentosa (Ashe) Palmer. (*C. pertomentosa* Ashe.) Johnson county. East third (map 98).

Crataegus viridis L. (*C. furcata* Sarg.) Cherokee, Linn counties. Southeast (map 99.)

Malus coronaria (L.) Miller. Sweet crabapple. Small tree in east (map 100).

Malus ioensis (Wood) Bailey. Iowa crabapple. Small tree, east, especially northeast (map 101).

Malus pumila Mill. Apple. Tree, escaped.

PRUNACEAE

Prunus americana Marsh. Wild plum. Tree in east two thirds and north part of west third (map 102).

Prunus angustifolia varians Wight & Hedrick. Chickasaw plum. Tree in Desha county (=Neosho? or Wilson county?) fide Sudworth.

Prunus angustifolia watsoni Waugh. Chickasaw plum. Shrub nearly throughout (map 103).

Prunus besseyi Bailey. Sandcherry. Shrub in north central sixth (map 104).

Prunus gracilis Engelm. & Gray. Shrub in southwest (map 105).

Prunus hortulana Bailey. Wild goose plum. Tree in southeast sixth to Wyandotte county (map 106).

Prunus lanata (Sudw.) Mack. & Bush. Plum. Tree in north half and southeast sixth (map 107).

Prunus mahaleb L. Mahaleb cherry. Tree escaping (map 108).

Prunus mexicana S. Wats. Mexican or bigtree plum. Tree in southeast (map 109).

Prunus munsoniana Wight & Hedr. Wild goose plum. Tree in southeast ninth (map 110).

Prunus orthosepala Koehne. ($\times$ *P. a. watsoni* $\times$ *P. americana*). Plum. Shrub originated in Ellis county.

Prunus persica Batsch. Peach. Tree, escaping (map 111).

Prunus rugosa Rydb. Shrub in southwest (map 112).

Prunus serotina Ehrh. Black cherry. Tree in east third (map 113).

Prunus virginiana L. Chokecherry. Shrub in east third (map 114).

Prunus virginiana melanocarpa (A. Nels.). Sarg. Western Chokecherry. Shrub in west two thirds (map 115).

MIMOSACEAE. Mimosa Family

Prosopis glandulosa Torr. (*Neltuma glandulosa* [Torr.] Mesquite. Shrub in south central (map 116).

CASSIACEAE. Cassia Family

Cercis canadensis L. Redbud, Judas tree. Tree in east two fifths (map 117).

Gleditsia triacanthos L. Honeylocust. Tree, native in east half, planted throughout (map 118).

Gleditsia triacanthos inermis Pursh. Thornless honey locust. Tree planted.

Gymnocladus dioica (L.) Koch. Coffeetree. Tree in east half (map 119).

FABACEAE. Pea and Bean Family

Amorpha canescens Pursh. Leadplant. Shrub in east two thirds (map 120).
Amorpha fragrans Sweet (*A. fruticosa angustifolia* Pursh). False indigo. Shrub presumably throughout (map 121).
Robinia pseudoacacia L. Black locust. Tree naturalized in east half and planted throughout (map 122).

GROSSULARIACEAE. Gooseberry Family

Ribes americanum Mill. Currant. Shrub in east (map 123).
Ribes missouriense Nutt. Missouri gooseberry. Shrub in east half (map 124).
Ribes odoratum Wendl. Flowering currant. Shrub in west four fifths (map 125).

PLATANACEAE. Planetree Family

Platanus occidentalis L. Sycamore. Lowland tree in east half (map 126).

ARISTOLOCHIACEAE. Dutchman's Pipe Family

Aristolochia tomentosa Sims. Dutchman's pipe. Liana in southeast (map 127).

CACTACEAE. Cactus Family

Opuntia imbricata (Haw.) Engelm. Tree cactus. Tree in west (map 128).

RHAMNACEAE. Buckthorn Family

Ceanothus americanus L. New Jersey tea. Shrub in east third (map 129).
Ceanothus ovatus Desf. New Jersey tea. Shrub in east two thirds (map 130).
Ceanothus ovatus pubescens T. & G. New Jersey tea. Shrub in east half (map 131).
Rhamnus lanceolata Pursh. Buckthorn. Shrub in east half (map 132).

VITACEAE. Grape Family

Ampelopsis cordata Michx. Liana, mostly in east half (map 133).
Parthenocissus quinquefolia (L.) Planch. Virginia creeper, woodbine. Liana, mostly in east half (map 134).
Parthenocissus quinquefolia hirsuta (Donn) Planch. Virginia creeper. Liana in east (map 135).
Parthenocissus vitacea (Knerr) Hitchc. Virginia creeper. Liana mostly east half (map 136).
Vitis aestivalis Michx. Wild grape. Liana in northeast (map 137).
Vitis cinerea Engelm. Winter grape. Liana in east two fifths (map 138).
Vitis cordifolia Michx. Frost grape. Liana in east third (map 139).
Vitis lincecumii glauca Munson. Wild grape. Liana in extreme east (map 140).
Vitis longii Prince. Wild grape. Mostly shrubby in southwest (map 141).
Vitis vulpina L. Riverbank grape. Liana, mostly throughout (map 142).

CELASTRACEAE. Stafftree Family

Celastrus scandens L. Climbing bittersweet. Liana in east two thirds (map 143).
Euonymus americanus Reg. Strawberry bush. Shrub in east (map 144).
Euonymus atropurpureus Jacq. Wahoo, burning bush. Shrub or small tree in east half (map 145).

ILICACEAE. Holly Family

Ilex decidua Walt. Holly, winterberry. Shrub in southeast twelfth (map 146).

STAPHYLEACEAE. Bladdernut Family

Staphylea trifolia L. Bladdernut. Shrub in east third (map 147).

ELAEAGNACEAE. Oleaster Family

Elaeagnus angustifolia L. Russian olive. Tree, escaping (map 148).
Elaeagnus argentea (Nutt). Buffalo berry. Shrub in west (map 149).

SAPINDACEAE. Soapberry Family

Sapindus drummondii H. & A. Western soapberry. Tree, especially in south central (map 150).

AESCULACEAE. Buckeye Family

Aesculus glabra Willd. Ohio buckeye. Tree in central east (map 151).
Aesculus glabra sargentii Rehder. Western buckeye. Shrub in east half (map 152).

ACERACEAE. Maple Family

Acer negundo L. (including the inconstant form *violaceum* Kirchner). Boxelder. Tree in east half and northwest fourth (map 153).
Acer negundo interius (Britton) Sarg. Boxelder. Tree in east (map 154).
Acer nigrum Michx. Black maple. Tree in extreme east (map 155).
Acer saccharinum L. Soft or silver maple. Tree in east third (map 156).
Acer saccharum Marsh. Hard maple. Tree in east third (map 157).

ANACARDIACEAE. Sumac Family

Rhus copallina L. Dwarf sumac. Shrub in northeast sixth + southeast fourth (map 158).
Rhus crenata (Mill.). Aromatic sumac. Shrub in east (map 159).
Rhus glabra L. Smooth sumac. Shrub throughout except southwest sixth (map 160).
Rhus toxicodendron negundo (Greene). Poison ivy. Liana in east half (map 161).
Rhus toxicodendron radicans (L.). Poison ivy. Liana in east two thirds (map 162).
Rhus toxicodendron rydbergii (Small). Poison ivy. Shrub in west half (map 163).
Rhus trilobata Nutt. Aromatic sumac (including *Rhus osterhoutii* Rydb. in Ellis and Morton counties). Shrub in west half (map 164).
Rhus trilobata serotina (Greene) Barkley [including *Rhus nortonii* (Greene)]. Aromatic sumac. Shrub, mostly east third, but scattered in northwest and north central (map 165).

JUGLANDACEAE. Walnut or Hickory Family

Carya alba L. Mockernut hickory. Douglas county (?) (map 166).
× Carya brownii Sarg. (*C. pecan* × *C. cordiformis*). Tree in southeast (Chautauqua county) (map 167).
Carya cordiformis (Wang.) K. Koch. Bitternut, yellowbud hickory. Tree in east third (map 168).

Carya laciniosa (Michx. f.) Loud. Kingnut, bigleaf shagbark hickory. Tree in southeast (map 169).

Carya ovalis obovalis Sarg. Pignut hickory. Tree in east (map 170).

Carya ovata (Mill.) K. Koch. Shagbark hickory. Tree mostly in east fourth (map 171).

Carya pecan (Marsh.) Engl. & Graebn. Pecan. Tree in southeast (map 172).

Carya villosa Ashe. Pignut hickory. Tree in east fourth south of Kansas river (map 173).

Juglans nigra L. Black walnut. Tree in east two thirds (map 174).

BETULACEAE. Birch Family

Betula nigra L. River birch. Tree in southeast (map 175).

Corylus americana Walt. American hazelnut. Shrub in east third (map 176).

Corylus rostrata Ait. Beakt hazelnut. Shrub in east fourth (map 177).

Ostrya virginiana (Mill.) K. Koch. Ironwood, hophornbeam. Small tree in east third (map 178).

Ostrya virginiana glandulosa (Spach) Sarg. Ironwood, hophornbeam. Small tree in east third.

FAGACEAE. Beech Family

Quercus alba L. White oak. Tree in east sixth (map 179).

Quercus bicolor Willd. White swamp oak. Tree in east (map 180).

Quercus borealis maxima (Ashe). Red oak. Tree in at least east third (map 181).

× Quercus bushii Sarg. (*Q. marilandica* × *Q. velutina.*) Tree in northeast (Doniphan county).

× Quercus hillii Trelease. (*Q. macrocarpa* × *Q. muhlenbergii.*) Tree in east third.

Quercus imbricaria Michx. Shingle oak. Tree in central east (map 182).

Quercus macrocarpa Michx. Bur oak. Tree in east three fifths (map 183).

Quercus marilandica Münch. Blackjack oak. Tree in east third (map 184).

Quercus marilandica ashei Sudworth. Tree in Riley county.

Quercus muhlenbergii Engelm. Chestnut or chinquapin oak. Tree in east half (map 185).

Quercus palustris Münch. Pin oak. Tree in southeast (map 186).

Quercus prinoides Willd. Chinquapin or scrub chestnut oak. Shrubby tree in east third (map 187).

Quercus shumardii Buckl. Shumard red oak. Tree in southeast (map 188).

Quercus shumardii schneckii (Britton) Sarg. Schneck oak. Tree in east, mainly southeast (map 189).

Quercus stellata Wang. Post oak. Tree in east third, mostly its south half (map 190).

× Quercus stelloides Palmer (*Q. prinoides* × *Q. stellata*). Tree in southeast (Wilson county).

Quercus velutina Lam. Black oak. Tree in east third (map 191).

CORNACEAE. Dogwood Family

Cornus asperifolia Michx. Ruffleaf dogwood. Shrub in east two thirds (map 192).

Cornus florida L. Flowering dogwood. Tree in extreme southeast (map 193).

Cornus instolonea (A. Nels.). Dogwood. Shrub in western Kansas—fide Rydberg.

Cornus interior Rydb. Dogwood. Shrub in east third (map 194).

Cornus obliqua Raf. Dogwood, kinnikinick. Scrub in east third (map 195).

RUBIACEAE. Madder Family

Cephalanthus occidentalis L. Buttonbush. Shrub mostly in east half (map 196).

CAPRIFOLIACEAE. Honeysuckle Family

Lonicera diocia glaucescens (Rydb.) Butters. Honeysuckle. Shrubby in northeast sixth (map 197).

Lonicera japonica Thunb. Japanese honeysuckle. Twining liana escaped in east third (map 198).

Lonicera prolifera (Kirchner) Rehder. Honeysuckle. Liana in northeast (map 199).

Sambucus canadensis L. Elder, elderberry. Shrub in east two thirds (map 200).

Symphoricarpos occidentalis Hook. Wolfberry. Shrub in west two thirds of north half and west fourth of south half (map 201).

Symphoricarpos orbiculatus Moench. Coralberry, buckbrush. Shrub in east three fourths (map 202).

Viburnum lentago L. Black haw, nannyberry. Shrub in extreme east (map 203).

Viburnum prunifolium L. Black haw, viburnum. Shrub or small tree in southeast (map 204).

Viburnum rufidulum Raf. Rusty black haw, viburnum. Shrub or small tree in southeast sixth (map 205).

COMPOSITAE. Composite Family

Baccharis neglecta Britton. Baccharis. Shrub in west (map 206).

Baccharis salicina T. & G. Groundseltree. Shrub in southwest fourth (map 207).

Baccharis wrightii A. Gray. Baccharis. Herbaceous from a thick woody base in southwest sixth (map 208).

INDEX TO FAMILIES OF WOODY PLANTS

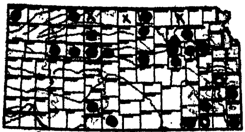
(The numbers indicate maps following)

Index to Genera

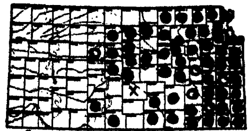
(The numbers indicate maps following)

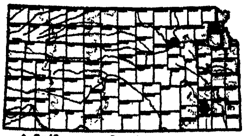
Index to Common Names

(The numbers indicate maps following)

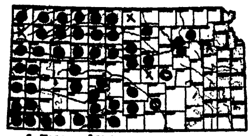

1. Juniperus virginiana.


2. Smilax bona-nox.


3. Smilax hispida.


4. Smilax pseudo-china.


5. Smilax rotundifolia.


6. Yucca glauca.

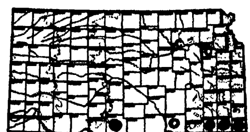

7. Asimina triloba.

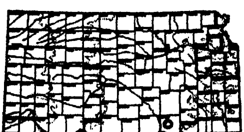

8. Benzoin aestivale.

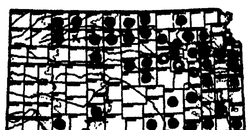

9. Sassafras variifolium.

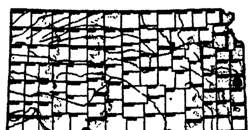

10. Tilia americana.

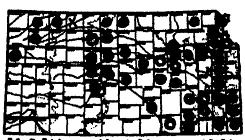

11. Tilia palmeri.


12. Celtis laevigata.

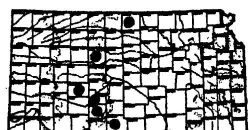

13. Celtis laevigata texana.


14. Celtis occidentalis.

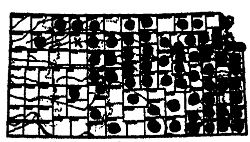

15. Celtis occidentalis canina.

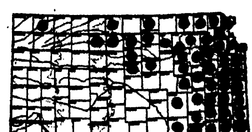

16. Celtis occidentalis crassifolia.

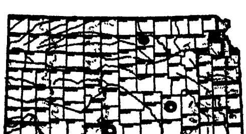

17. Celtis pumila.

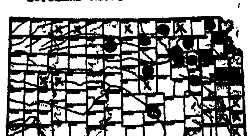

18. Celtis reticulata.


19. Celtis rugulosa.

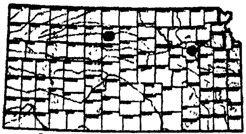

20. Ulmus americana.

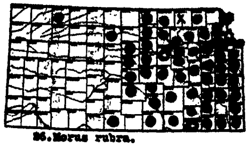

21. Ulmus fulva.

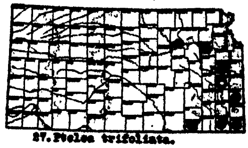

22. Ulmus racemosa.

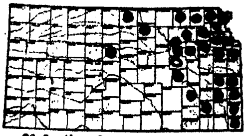

23. Maclura pomifera.

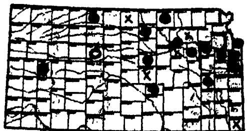

24. Morus alba.


25. Morus nigra.

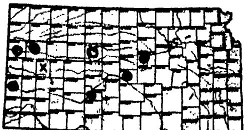

26. Morus rubra.

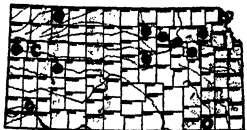

27. Ptelea trifoliata.

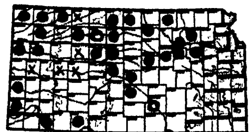

28. Zanthoxylum americanum.

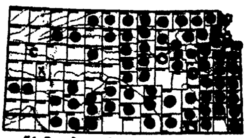

29. Ailanthus altissima.

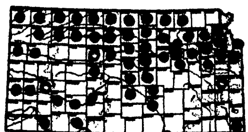

30. Ascyrum hypericoides.


31. Tamarix gallica.

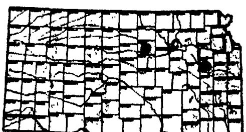

32. Populus alba.

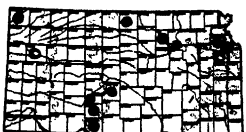

33. Populus sargentii.


34. Populus virginiana.

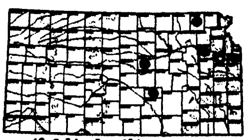

35. Salix amygdaloides.

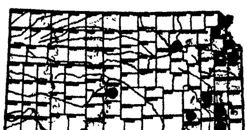

36. Salix amygdaloides wrightii.

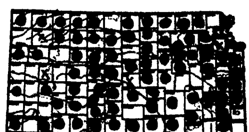

37. Salix babylonica.

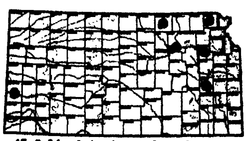

38. Salix cordata.


39. Salix exigua luteosericea.

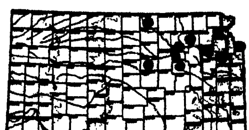

40. Salix fragilis.


41. Salix humilis rigidiuscula.

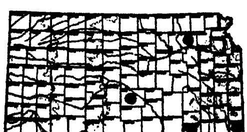

42. Salix interior.


43. Salix interior pedicellata.

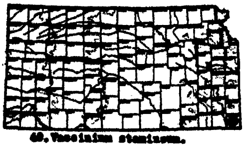

44. Salix longipes wardii.

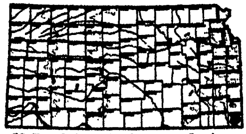

45. Salix missouriensis.


46. Salix nigra.

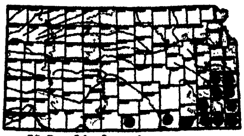

47. Salix tristis.

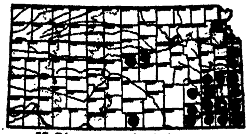

48. Vaccinium arboreum.

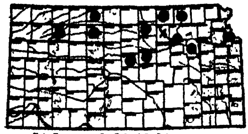

49. Vaccinium stamineum.


50. Vaccinium stamineum neglectum.

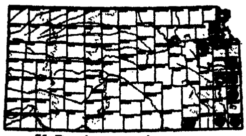

51. Vaccinium vacillans.

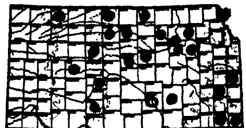

52. Bumelia lanuginosa.

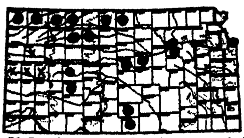

53. Diospyros virginiana.

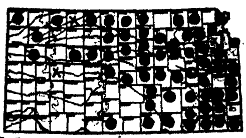

54. Lycium halimifolium.


55. Forestiera acuminata.

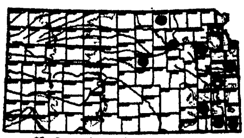

56. Fraxinus americana.

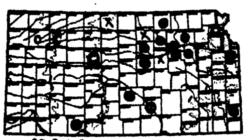

57. Fraxinus pennsylvanica.

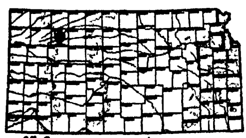

58. Fraxinus pennsylvanica campestris.


59. Fraxinus pennsylvanica lanceolata


60. Fraxinus quadrangulata.

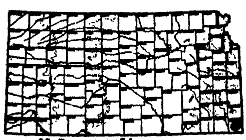

61. Campsis radicans.


62. Catalpa speciosa.


63. Cercocarpus montanus.


64. Rosa arkansana.


65. Rosa blanda.


66. Rosa carolina.

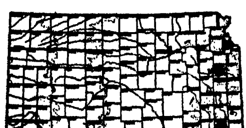

67. Rosa conjuncta.

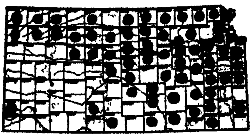

68. Rosa lyoni.


69. Rosa rubifolia.

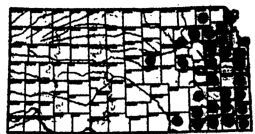

70. Rosa rubiginosa.


71. Rosa serrulata.


72. Rosa setigera.


73. Rosa suffulta.

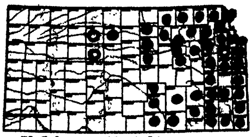

74. Rosa woodsii.

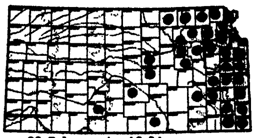

75. Rubus flagellaris.

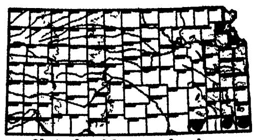

76. Rubus flagellaris occidentalis.


77. Rubus laudatus.


78. Rubus nigrobaccus.

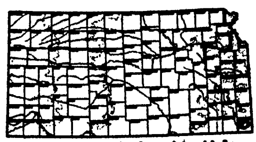

79. Rubus occidentalis.


80. Rubus ostryifolius.

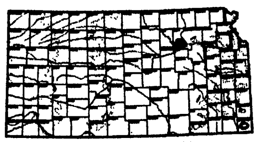

81. Amelanchier canadensis.

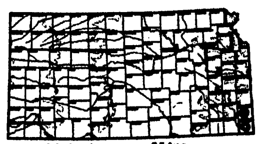

82. Amelanchier laevis.

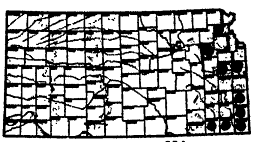

83. Crataegus calpodendron.

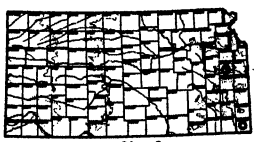

84. Crat. calpodendron hispidula.


85. Crataegus calpodendron obesa.

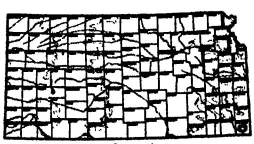

86. Crataegus coccinioides.

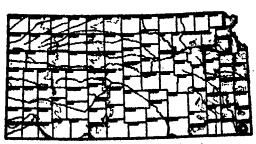

87. Crataegus collina.


88. Crataegus crusgalli.

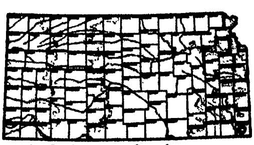

89. Crataegus discolor.


90. Crataegus engelmanni.

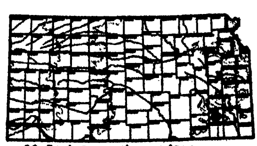

91. Crataegus lanuginosa.

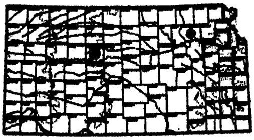

92. Crat. mackenzii bracteata.

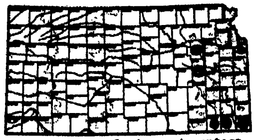

93. Crataegus mollis.


94. Crataegus palmeri.


95. Crataegus regalis paradoxa.


96. Crataegus stevensiana.

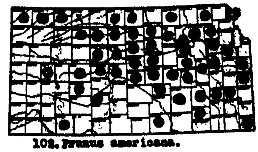

97. Crataegus succulenta.

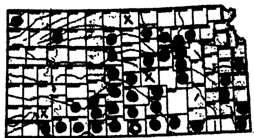

98. Crat. succulenta pertomentosa.

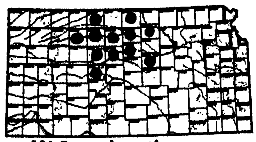

99. Crataegus viridis.

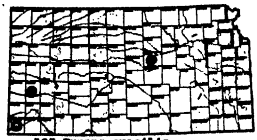

100. Malus coronaria.

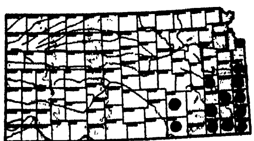

101. Malus ioensis.

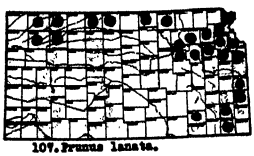

102. Prunus americana.

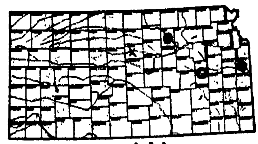

103. Prunus angustifolia watsoni.


104. Prunus besseyi.

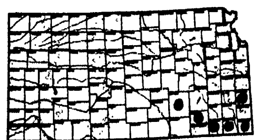

105. Prunus gracilis.

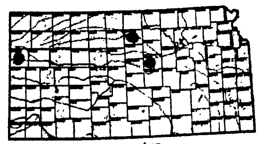

106. Prunus hortulana.


107. Prunus lanata.

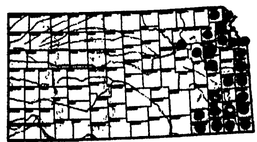

108. Prunus mahaleb.

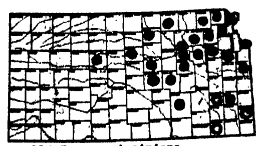

109. Prunus mexicana.

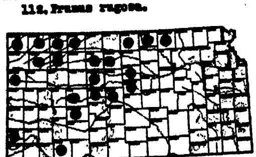

110. Prunus munsoniana.


111. Prunus persica.

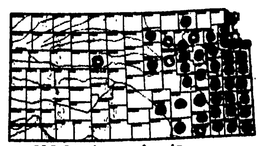

112. Prunus rugosa.

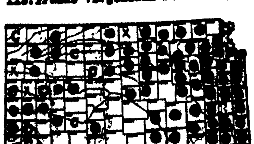

113. Prunus serotina.

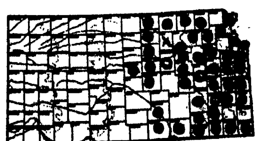

114. Prunus virginiana.

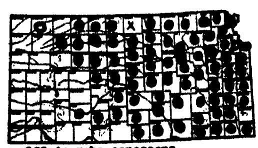

115. Prunus virginiana melanocarpa.

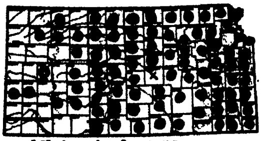

116. Prosopis glandulosa.

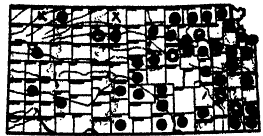

117. Cercis canadensis.

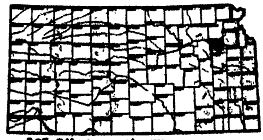

118. Gleditsia triacanthos.

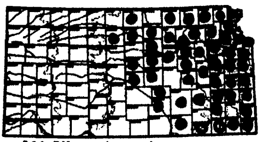

119. Gymnocladus dioica.

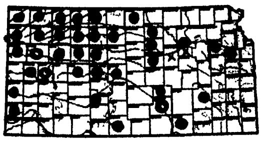

120. Amorpha canescens.

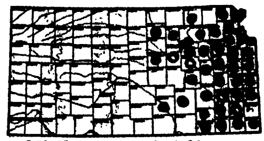

121. Amorpha fragrans.


122. Robinia pseudoacacia.

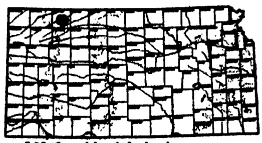

123. Ribes americanum.

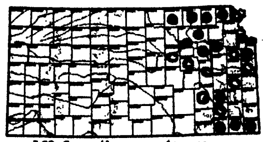

124. Ribes missouriense.

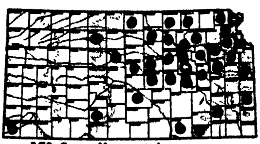

125. Ribes odoratum.

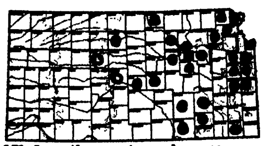

126. Platanus occidentalis.

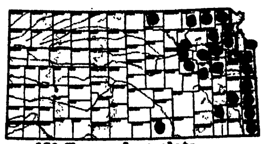

127. Aristolochia tomentosa.

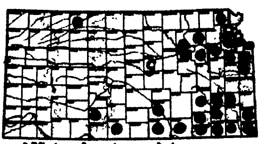

128. Opuntia imbricata.

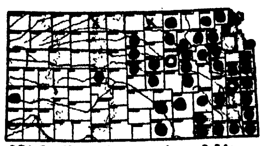

129. Ceanothus americanus.

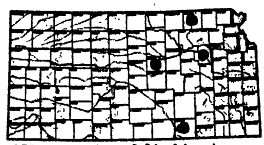

130. Ceanothus ovatus.

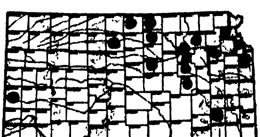

131. Ceanothus ovatus pubescens.

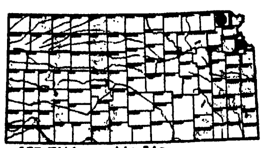

132. Rhamnus lanceolata.

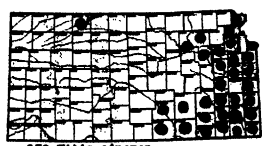

133. Ampelopsis cordata.

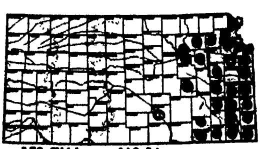

134. Parthenocissus quinquefolia.


135. Par. quinquefolia hirsuta.

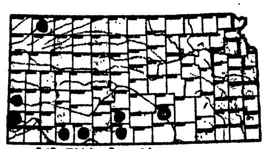

136. Parthenocissus vitacea.

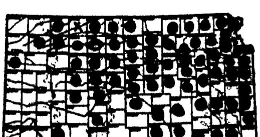

137. Vitis aestivalis.

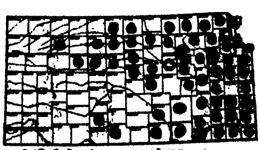

138. Vitis cinerea.


139. Vitis cordifolia.

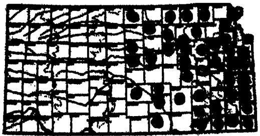

140. Vitis lincecumii glauca.

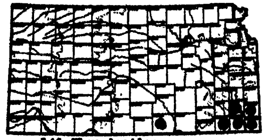

141. Vitis longii.


142. Vitis vulpina.


143. Celastrus scandens.


144. Evonymus americanus.

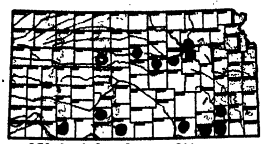

145. Euonymus atropurpureus.


146. Ilex decidua.

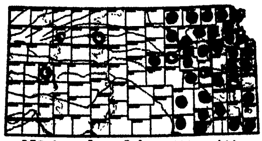

147. Staphylea trifolia.

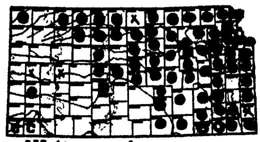

148. Elaeagnus angustifolia.


149. Elaeagnus argentea.

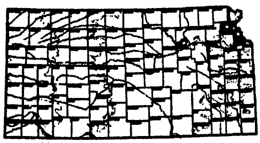

150. Sapindus drummondii.

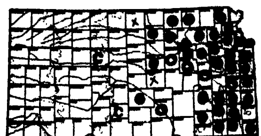

151. Aesculus glabra.

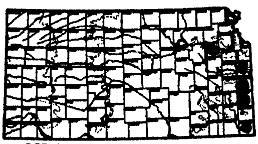

152. Aesculus glabra sargentii


153. Acer negundo.


154. Acer negundo interius.

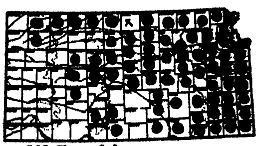

155. Acer nigrum.


156. Acer saccharinum.

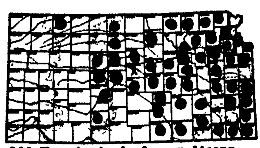

157. Acer saccharum.

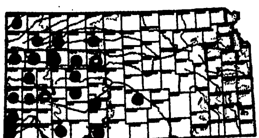

158. Rhus copallina.

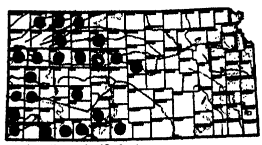

159. Rhus crenata.

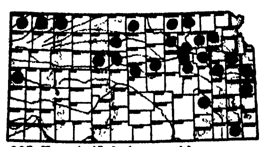

160. Rhus glabra.

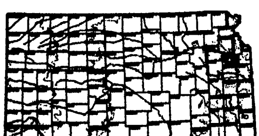

161. Rhus toxicodendron negundo.


162. Rhus toxicodendron radicans.

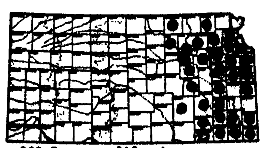

163. Rhus toxicodendron rydbergii.

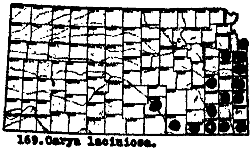

164. Rhus trilobata.

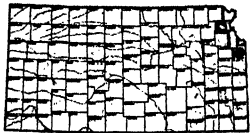

165. Rhus trilobata serotina.

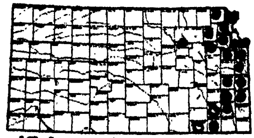

166. Carya alba. ?

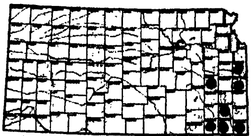

167. XCarya brownii.

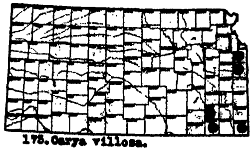

168. Carya cordiformis.

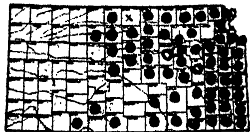

169. Carya laciniosa.

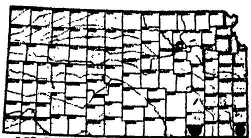

170. Carya ovalis obovalis.

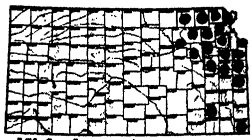

171. Carya ovata.


172. Carya pecan.

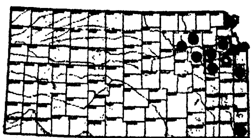

173. Carya villosa.

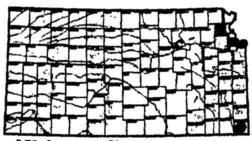

174. Juglans nigra.

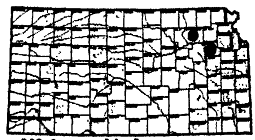

175. Betula nigra.


176. Corylus americana.

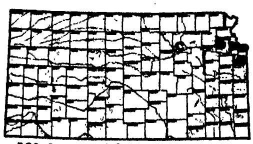

177. Corylus rostrata.

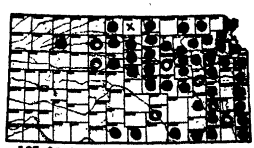

178. Ostrya virginiana.

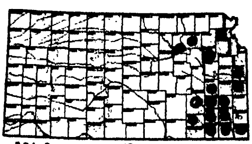

179. Quercus alba.

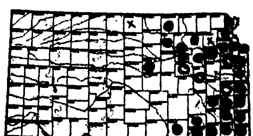

180. Quercus bicolor.

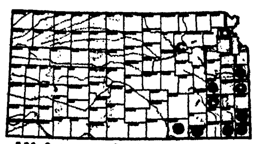

181. Quercus borealis maxima.

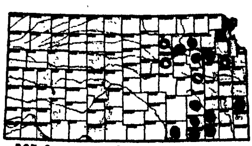

182. Quercus imbricaria.

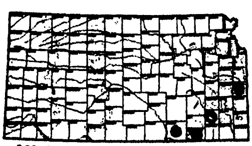

183. Quercus macrocarpa.

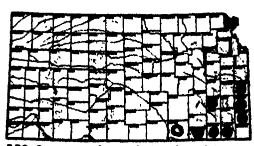

184. Quercus marilandica.

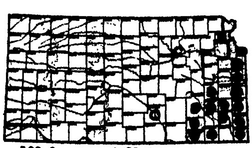

185. Quercus muhlenbergii.

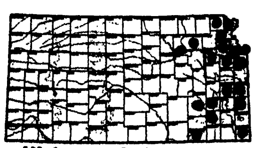

186. Quercus palustris.

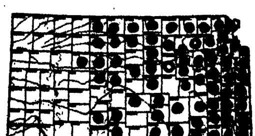

187. Quercus prinoides.

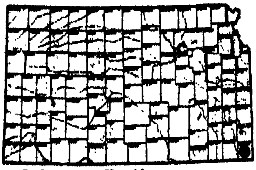

188. Quercus shumardii.


189. Quercus shumardii schneckii.

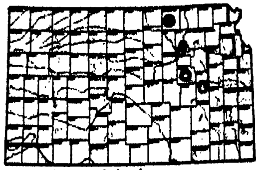

190. Quercus stellata.


191. Quercus velutina.

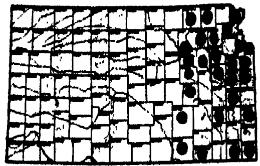

192. Cornus asperifolia.



193.Cornus florida.

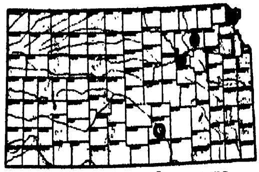


194.Cornus interior.

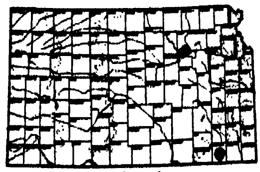


195.Cornus obliqua.

196.Cephalanthus occidentalis.

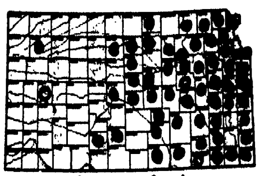


197.Lonicera dioica glaucescens.

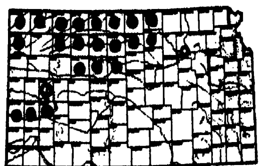


198.Lonicera japonica.

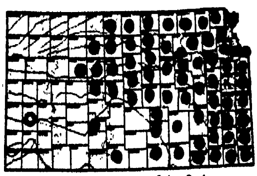
199.Lonicera prolifera.



200.Sambucus canadensis.

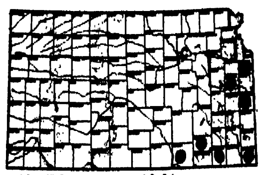


201.Symphoricarpos occidentalis.

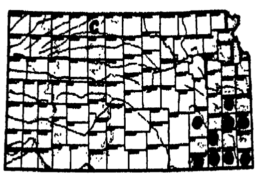


202.Symphoricarpos orbiculatus.

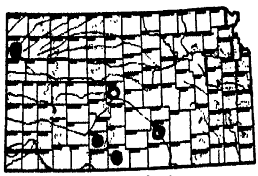
203.Viburnum lentago.



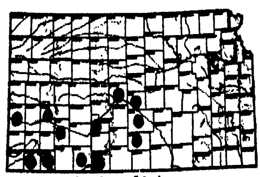
204.Viburnum prunifolium.



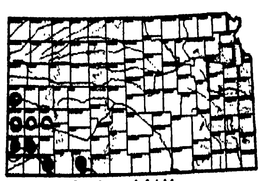
205.Viburnum rufidulum.



206.Baccharis neglecta.



207.Baccharis salicina.



208.Baccharis wrightii.

Taraxacum laevigatum f. scapifolium, a New Form of Dandelion[1]

FRANK C. GATES, Kansas State College, Manhattan, Kan., and
S. FRED PRINCE, Galena, Mo.

In the southern part of Stone county, southwestern Missouri, dandelions are uncommon except on a few lawns replanted with grass seed from the north. Both *Taraxacum vulgare* (Lam.) Schrank (*T. officinale* Weber) and *Taraxacum laevigatum* (Willd.) D. C. (*T. erythrospermum* Andrz.) were present here and there in the area. In the earlier days *T. laevigatum* was quite typical, but suddenly one great old plant at Galena had foliage leaves on all of its many flowerscapes. Now all the plants seem to be this scapifoliate form.

Seeds from the best developed plant (figs. 1 and 2) were planted both in pots and in the open ground. In May, 1937, every new plant checked true in vegetative features, and September 15, 1937, began to produce flower heads. Each scape had a long strapshapt leaf on it. Some of these leaves were a little lobed (figs. 3a, 4). On the strongest plant they were lobed more like those of figures 1 and 2.

Since this form suddenly appeared in the general population, has bred true in all the experimental plantings conducted, and has assumed dominance in the dandelion population, it would seem reasonable to give it a name.

Taraxacum laevigatum f. scapifolium forma nova

Planta perennis ex specie differt foliis radicalibus pedunculatisque et interdum capitulum 1-5 foliis laciniatis subtendentibus.

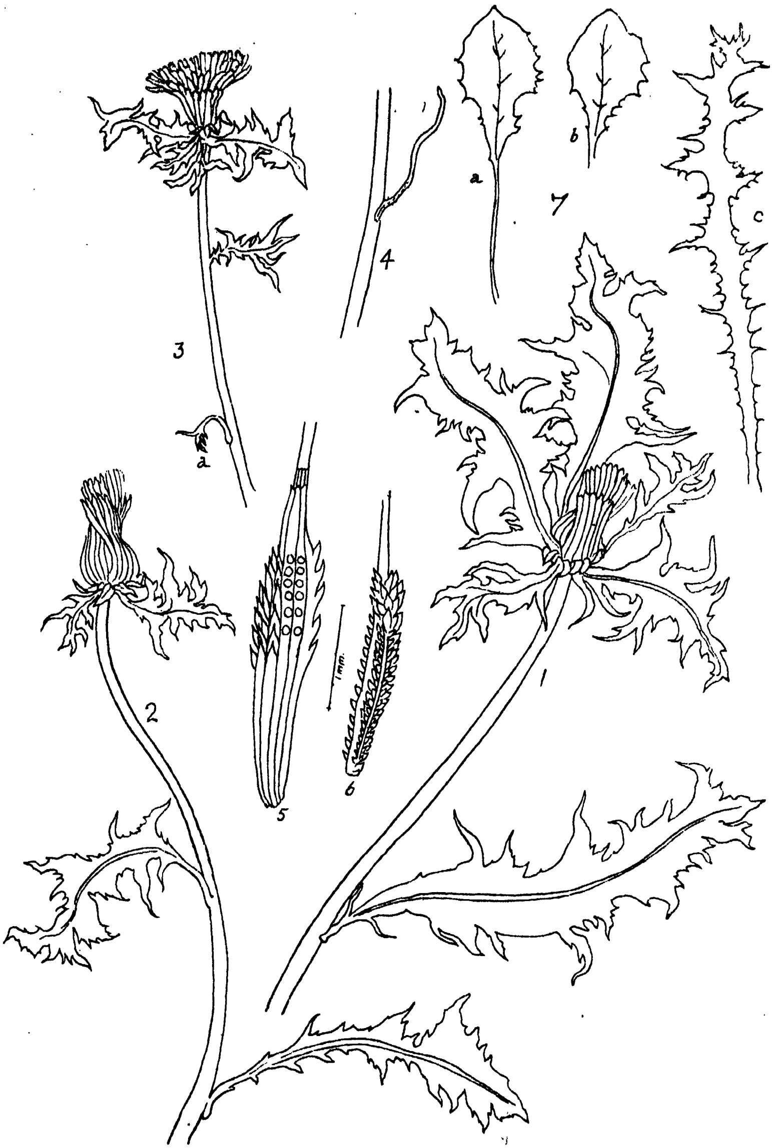
A rosette forming, perennial tap-rooted plant. Crown leaves runcinate-pinnatifid, usually very finely and deeply lobed even to the very tips on older plants. Scapes noticeably fuzzy to almost hairy, with one or more strapshapt to laciniate leaves present on the scapes, occasionally even to the base of the capitulum. Capitulum, flowers and seeds similar to the species except for the occasional 1-5 laciniate leaves just below the normal involucral bracts. Flowering time later than that of *Taraxacum vulgare* where the two grow together. Waste ground, Stone county, Missouri.

Type collected by S. Fred Prince, at Galena, Mo., May 27, 1938, and deposited at the herbarium of Kansas State College, at Manhattan.

(See plate on next page.)

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Contribution No. 383, Department of Botany and Plant Pathology, Kansas State College.



A NEW FORM OF DANDELION

FIGS. 1 and 2. From the oldest plant (first found).
FIG. 3. From a seemingly younger plant, scarcely yet outgrown its strapshapt leaf.
FIG. 4. The typical first leaf on the flowerscape.
FIG. 5. Akene of Taraxacum vulgare.
FIG. 6. Akene of Taraxacum laevigatum.
FIG. 7. First leaves from seeding. *a*, 1 month old; *b*, 1 week old; *c*, youngest leaf of a very old plant.

Kansas Mycological Notes, 1937 [1]

C. O. JOHNSTON, U. S. Department af Agriculture, and TRAVIS E. BROOKS, Kansas State College, Manhattan, Kan.

The growing season of 1937 was divided into two distinct and sharply contrasted periods as regards meteorologic conditions affecting the development of fungi and plant diseases. The late spring period, composed of May and the first three weeks of June, was marked by frequent rains of moderate intensity. Although often below normal in amount, the rains occurred over wide areas at intervals of a few days, for a period of nearly a month. This was especially noticeable in the eastern half of the state. Mean temperatures during the same period were slightly above normal. The combination of frequent rains, heavy dews, and increased temperatures favored the development of cereal rusts. As a consequence, a severe epidemic of stem rust occurred in the 1937 wheat crop.

The second weather condition affecting mycological developments in 1937 was a long period of heat and drought beginning about June 20 and extending to September 4. This could be considered merely a prolongation of the period of extreme drought which began in 1930. Except for 1931, when rainfall for the year was about normal, there has been a shortage of rainfall in each of the last eight years. The cumulative shortage of moisture for this period had reached 72 inches in many parts of eastern Kansas by the end of 1937. This long period of drought has resulted in the death of large numbers of trees and shrubs in nearly all parts of the state. However, fungous organisms have had little to do with the decrease in vegetation and many situations in which mycological specimens formerly were abundant now are so throughly dried out that fungi are difficult to find. Drought and high temperatures in 1937 also reduced the amount of disease in late summer crops, such as corn and sorghum.

The 1937 epidemic of stem rust of wheat was one of the most severe ever experienced in Kansas. The infection appeared in counties along the Oklahoma line about May 20 and moved gradually northward, reaching extreme severity in the eastern four ranges of counties. The average loss was estimated at approximately 27 percent for that area. The amount of infection and losses caused by it gradually decreased to the westward and were insignificant in the western half of the state. The drought of the winter and early spring of the 1937 crop season eliminated much of the winter wheat in the western half of Kansas, but the acreage in the eastern half of the state was unusually large. The heavy epidemic of stem rust in the eastern counties, therefore, dealt a severe blow to the wheat crop of Kansas. It is estimated that the average loss for the state was about 6.6 percent, resulting in a reduction in yield of more than ten million bushels.

Several other rusts were present in abundance in 1937, but were overshadowed by the stem rust of wheat epidemic. Leaf rust of wheat was unusually severe in the northeastern fourth of the state late in the season, but

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Contribution No. 879, Department of Botany, Kansas State College.

was less abundant than usual in other parts of the state. Both stem and crown rust were severe on oats in some localities of northeastern Kansas very late in June, but were not uniformly distributed. Stem rust on barley was very heavy, especially in the central part of the state, and probably resulted in greater losses than those caused by smuts of barley. Rust was severe on sweet corn grown in home and market gardens in the Kaw River Valley. It was particularly heavy on late plantings, causing considerable premature drying of the leaves. *Puccinia sorghi* also was observed to be heavy on the leaves of teosinte (*Euchlena mexicana*) plants growing in experimental plots at Manhattan. Tassels of the same plants also were severely infected with corn smut (*Ustilago zeae*).

Sorghum rust (*Puccinia purpurea*) was encountered in the vicinity of Manhattan for the first time in several years. It appeared in experimental plots on September 17. About the same time it was collected on sorghum growing in creek bottoms west of Manhattan. On the farm of Bruce Wilson, near Keats, hybrid plants of a natural cross between Atlas sorgo and Johnson grass was found to be infected with sorghum rust. The hybrid plants, which were growing in a field of Atlas sorgo, had typical F_1 characteristics, such as great vigor, profuse tillering, and large, open, and partially sterile panicles. Many of the hybrids also possessed short but typical rootstocks.

Another rust disease which appeared late in the crop season in the vicinity of Manhattan was alfalfa rust (*Uromyces striatus*). Although alfalfa was injured by drought and had little foliage during most of the summer, many fields had an abundance of new growth after the rains began in September. Rust was severe on new growth in irrigated experimental plots at Manhattan during September and October. Considerable rust also developed on new growth in fields located in river and creek valleys in the eastern third of the state.

Not many cases of fungi attacking living deciduous trees were observed in 1937. Elm leaf spot caused by *Gnomonia ulmea* was prevalent on leaves of the American elm in eastern Kansas, but the red and Chinese elms seemed to be little affected. An unusual case of the development of a fungous disease on trees was a heavy infection of rust caused by *Tranzschelia pruni-spinosae* on the leaves of wild black cherry (*Prunus serotina*) seedlings growing in a soil-conservation nursery at Manhattan. Overhead irrigation used to assure rapid growth of the seedlings also favored the development of rust which became so severe that most seedlings were defoliated.

Despite the long continued drought and the heat of the summer of 1937, the junior author was able to collect fourteen species of fungi which have not previously been reported as occurring in Kansas, or which were found in the state on new hosts. These were identified as far as possible and were then submitted to W. W. Diehl, Vera K. Charles, or J. A. Stevenson, mycologists of the United States Department of Agriculture, Washington, D. C., for verification. Most of the fungi were saprophytes found growing on dead wood, but a few were active parasites. The following fungi proved to be unreported for Kansas and have been added to the herbarium of the Department of Botany, Kansas State College:

Amphiloma lanuginosum (Hoffm.) Nyl.—on cottonwood.
Caloplaca gilva (Hoffm.) Zahlbr.—on rotted elm stump.

Eutypa scoparia (S.) Ell. & Ev.—on elm.
Hypoxylon serpens Fr.—on decaying apple wood.
Lentinus vulpinus Fr.—on cottonwood log.
Mattirolia chrysogramma (Ell. & Ev.) Sacc.—on dead cherry limb.
Nummularia clypeus (S.) Cke.—on elm.
Physcia stellaris (L.) Nyl.—on decaying wood.
Puccinia extensicola erigerontis Arth. I—on Erigeron ramosus (Walt.).
Puccinia extensicola oenotherae (Mont.) Arth. I—on Oenothera laciniata Hill.
Solenia brenckleana (S.) Cke.—on elm log.
Tylostoma rufum Lloyd—on decaying wood.
Volvaria bombycina (Schaeffer) Quelet—on cottonwood logs.
Xylaria multiplex Kze.—on cottonwood.

A Yeastlike Organism Isolated From the Human Scalp

CLINTON C. McDONALD, The University of Wichita, Wichita, Kan.

Yeastlike fungi have received some attention as a part of the flora of the skin by a few recent experimenters. Croft and Black (2) isolated twenty-nine cultures of yeastlike organisms from the hands of twenty-two persons whose hands were moist most of the time. White (5) reports superficial yeast infections of the glabrous skin. Wilenczyk (6) has indicated asci in scabs of mycotic eruptions and in seborrhea. Cornbleet and Dowling (1) speak of the auto-sterilizing power of skin against yeasts.

Duffy (3) used a hair agar medium and secured a growth of yellow yeastlike colonies from seborrhea scales. MeLeod and Duffy (4) state that *Pityosporon ovale* belongs to the Blastomycetes and that it was grown on Sabouraud's test medium. They produced lesions on normal patients as well as on those already affected by inoculation. No mention is made of recovering the species from experimental lesions.

The present study is concerned with a yeastlike organism isolated from the scalp of a person that was afflicted with an unusually annoying accumulation of white membranous scales in the hair. These scales loosened easily from the skin and would be followed by new accumulations within three to five days.

Characteristic small white colonies were obtained by inoculation of various mediums with these scales. Any of the acid mediums such as: Potato dextrose agar, Sabouraud's maltose agar, Sabouraud's dextrose agar, saccharose agar or malt extract agar will yield representative growth. The culture plates have a yeastlike odor.

In obtaining yeasts and molds for study it has been the practice to expose culture plates by shaking the hair over the plate for a short time. The author has noticed over a period of more than ten years that such plates are likely to show a large number of yeast colonies. There has also been a correlation between the colonies obtained and the extent to which scales were evident on the persons scalp. In many cases the colonies thus obtained are larger than these under consideration, which indicates that such trouble, if due to these organisms producing such varied colonies, is not likely caused by a single species of organism. This report, however, refers directly to a single organism.

These small colonies are easily isolated on potato dextrose agar slants. Growth characteristics indicates a single organism. Staining reactions and morphological characteristics also indicate uniformity among the colonies. In Smith fermentation tubes abundant growth and acid production were noted in the following broth mediums: lactose, lactose peptone bile, dextrose, saccharose, and malt extract. Growth was completely inhibited in lactose gentian violet broth. Cultures are viable after four months on potato dextrose agar.

Further work is in progress on this organism. Complete identification will be made and behavior studied when grown in the presence of numerous bactericides. The latter should prove valuable in helping control its growth on the scalp.

Trans. Kansas Acad. Science, Vol. 41, 1938.

LITERATURE CITED

1. CORNBLEET and MONTGOMERY. Autosterilizing Power of Skin against Yeasts. Arch. Dermatol. and Syphilol. 23:908-919. 1931.
2. CROFT, CHARLES C., and BLACK, L. A. Yeastlike Fungi Isolated from Normal Skin. Jr. of Bact. 35:37-38. 1938.
3. DUFFY, FRANCIS M. Seborrhea (Bacterial Etiology of). Arch. Dermatol. and Syphilol. 20:358-361. 1929.
4. MACLEOD and DOWLING. An Experimental Study of the Pityrosporon of Melassez: Morphology, Cultivation and Pathogenicity. Brit, Jr. Dermatol. and Syphilol. 40:139-148. 1928.
5. WHITE, CLEVELAND. Superficial Yeasts Infections of the Glabrous Skin. Arch. Dermatol. and Syphilol. 18:429-438. 1928.
6. WILENCZYK, A. Asci in Scales of Mycotic Eruptions and of Seborrhea. Comp. Rend. Soc. Biol. 99 (27). 1928. Reviewed in Biol. Ab., Vol. 4, No. 10, 1930. 25140.

An Anatomical Study of *Asclepias pumila, A. incarnata* and *A. quadrifolia*

M. W. MAYBERRY, University of Kansas, Lawrence, Kan.

The species of milkweed referred to in this paper grow in three quite different types of environment. Material of *Asclepias pumila* was obtained from the prairie near Pratt, Kan. It is typical of the dry plains. *Asclepias incarnata,* a swamp plant, was taken from the Scott County State Park, where the plants were growing with their roots in mud at the edge of a lake. *Asclepias quadrifolia,* a plant of woodlands, was collected in southeastern Kansas.

The growth habit of the three species is comparatively different. Each is a herbaceous perennial, *Asclepias pumila* being perennial by a slender, elongated rhizome which superficially appears as a "tap" root and is described as such by Rydberg[1] (fig. 2). The rhizome of *Asclepias quadrifolia* is relatively short and thickened (fig. 1). *Asclepias incarnata* has only a slightly thickened base from which lateral buds give rise to new branches the following year (fig. 4).

Several unbranched stems are commonly found arising from nearly the same position in *A. pumila,* while *A. incarnata* may branch towards the apex of the several upright stems. *A. pumila* and *A. quadrifolia* are slender-stemmed, while *A. incarnata* is comparatively thick-stemmed and woody. The species range in height from 1-2 dm. for *A. pumila;* 3-6 dm. for *A. quadrifolia* to 6-20 dm. for *A. incarnata.* The stems of *A. pumila* are densely crowded with linear alternate leaves, while *A. quadrifolia* has only 3-4 pairs of ovate-lanceolate leaves. *A. incarnata* is intermediate, the leaves being linear-lanceolate in shape.

The root systems of the three species are variable in that *A. incarnata* has a conspicuously massed group of course roots emerging from the base of the stem, while those of *A. quadrifolia* and *A. pumila* are finely branched and emerge all along the extended rhizome (figs. 4, 1 and 2 respectively).

ANATOMICAL DISCUSSION

Leaves of the species studied present a number of structural modifications. Superficial views of bleached leaves show comparatively typical epidermal cells in each species. The lateral epidermal walls of *A. quadrifolia* are slightly undulated. Trichomes are sparsely scattered over both surfaces of *A. incarnata,* being most abundant along the midrib on the underside. A few trichomes occur on the upper surface of the leaves of *A. quadrifolia;* however, none are found on the leaves of *A. pumila.* Relatively wide variations are found in the number of stomata per square millimeter in each of the species, indicated by the following table:

A. incarnata:

Upper epidermis	95 per sq. mm.
Lower epidermis	125 per sq. mm.

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Flora of the Prairies and Plains.

A. quadrifolia:

Upper epidermis	None
Lower epidermis	240 per sq. mm.

A. pumila:

Upper epidermis	20 per sq. mm.
Lower epidermis	10 per sq. mm.

In *A. incarnata* the stomata are sunken, each guard cell lying beneath a subsidiary epidermal cell (fig. 13). Venation in the expanded leaf blades of *A. incarnata* and *A. quadrifolia* is profusely branched, with approximately 30 vein meshes and 20 vein meshes per square millimeter, respectively. In *A. pumila* the venation is less branched, as would be expected in such a linear-shaped leaf. Veins emerge from the midrib and run more or less parallel to the longitudinal extent of the leaf.

Studies of the cross sections of leaves of the above species make evident additional variations in structure. The occurrence of a relatively thick cuticle is common to each; however, the outer epidermal wall of *A. pumila* is noticeably more thickened than either *A. incarnata* or *A. quadrifolia.* The mesophyll of *A. pumila* (fig. 16) is composed of compactly arranged palisade-like cells producing a centric leaf type, while the leaves of *A. incarnata* (fig. 18) and *A. quadrifolia* (fig. 19) are bifacial. An extreme contrast in compactness of the mesophyll exists between leaves of *A. pumila* and *A. quadrifolia. A. quadrifolia* has the greater proportion of the mesophyll region composed of intercellular spaces. The single row of palisade mesophyll is poorly developed. There is more of an intermediate condition of the mesophyll in *A. incarnata* in respect to relative compactness. The palisade mesophyll is principally made up of two rows of cells with compactly arranged spongy mesophyll. The two give a compactness to the leaf not common to typical mesophytic plants. The vascular arc in the midrib of each species has groups of phloem above and below the xylem corresponding to the existence of intra-and extraxylary phloem in the stems, and forming an amphicribral arrangement (fig. 11). As is common to the Asclepidaceae, there are laticiferous tubes in the leaves associated with the vascular system.

The tissues in the above-ground stems of the three species are comparable in arrangement, varying only in lesser details (fig. 9). A cuticle is associated with the intact epidermis in each species, with conspicuous masses of waxy deposition on the stems of *A. pumila* and *A. quadrifolia.* The cuticle of *A. incarnata* averages .007 mm. in thickness as compared to its being relatively less thick in *A. quadrifolia* and *A. pumila.*

The following features relating to structure are characteristic of the three species:

1. Isolated groups of unlignified fibrous sclerenchyma in the cortex.
2. Laticiferous tubes located in the cortex, phloem and pith.
3. Intraxylary phloem occurring in isolated groups in the medullary sheath.
4. Rosette crystals of calcium oxalate dispersed chiefly in the cortex and pith.
5. Cells of the innermost part of the pith cylinder breaking down early.
6. Vascular tissue forming a continuous cylinder.
7. Occurrence of oil globules in all parenchyma.

The relative amounts of xylem in comparable parts of the stem in each species correspond to the habit of the plant. Approximately 40 percent of

the cross sectional area is made up of xylem in *A. incarnata,* as compared to approximately 25 percent in *A. quadrifolia* and 30 percent in *A. pumila.*

Rhizomes of *A. pumila* and *quadrifolia* are essentially storage organs, being composed largely of xylem parenchyma. In each case this tissue and the outer lying phloem is richly filled with oil globules and starch. Scattered through the masses of xylem parenchyma are groups of tracheal vessels. At the periphery a protective layer of cork is found.

Structural variations are far more prominent in the roots of the three species than in those found in the stems. The course, fibrous roots of *A. incarnata* (fig. 5), as seen in cross section, have a conspicuous cortical parenchyma region protected by a suberized hypoderm. *A. pumila* (fig. 3) and *A. quadrifolia* (fig. 6) have relatively a more narrow cortex, but, at the stage studied, have a suberized hypodermis. The cortical cells in each species are filled with starch grains and some oil globules. In the latter two species a conspicuous number of calcium oxalate crystals occur. An endodermis is found in each, forming a continuous cylinder in *A. pumila* and *A. incarnata* but a more or less broken cylinder in *A. quadrifolia.* The endodermal cells in each case are uniformly thin-walled and suberized. The development of xylem in *A. incarnata* suggests a tetrarch arrangement; in *A. quadrifolia* triarch; while in *A. pumila* the arrangement is not evident for there is one solid strand. The xylem region of *A. quadrifolia* is composed of three radiating zones of tracheal vessels alternating with conspicuously developed zones of xylem parenchyma. This area in *A. incarnata* is composed of four groups of tracheal vessels towards the periphery, with lignified parenchyma at the center.

ECOLOGICAL DISCUSSION

The varied habitats of the three species suggest possibilities of internal structural variations in each which could be correlated with their environment. The greatest difference in environment exists in the habitats of *Asclepias pumila* and *A. incarnata* from that of *A. quadrifolia.* The first two have their above-ground parts in comparable situations, since each typically is found in the southwestern part of the state. However, the available water for each would be different, since *A. incarnata* is rooted in the mud of swampy areas, while *A. pumila* is in dry soil. *A. quadrifolia* grows, as previously stated, in woodlands, thus being somewhat protected from direct sun rays and excessive transpiration.

The two species *A. pumila* and *A. incarnata* exhibit internal structural characteristics which can be definitely correlated with the environment of their above-ground parts. The leaf surface in *A. pumila* is less than the average and exhibits a type of xerophily by being almost needle-shaped.

The leaf epidermises in each of the two species are covered by a well-defined cuticle. The outer walls are unusually thickened, especially in leaves of *A. pumila.* Stomata are present in both the upper and the lower epidermis. The average number per square millimeter of leaf surface is greatly reduced when compared to an average for mesophytic types. The greater number are found in *A. incarnata,* but an average of 195 per square millimeter in the lower epidermis and 95 per square millimeter in the upper totals less than the average found for mesophytic plants. In addition the stomata of *A. incarnata* are sunken beneath two bordering subsidiary epidermal cells. Trichomes occurring

on the epidermises of *A. incarnata* are not of sufficient frequency to be significant in respect to xeromorphy.

The mesophyll regions of the leaves of both *A. pumila* and *A. incarnata* are typical of plants growing in strong light and exposed to excessive transpiration. The compactness of this region is evident in figures 16-18.

Leaves of *A. quadrifolia* are indicative of this plant's habitat as much as are those of *A. pumila* and *A. incarnata*. The structural arrangement most striking in correlation with *A. quadrifolia* and its woodland habitat is found in the mesophyll region. The mesophyll is, as previously described, extremely loose in arrangement, with but one row of palisade cells and large intercellular space system in the spongy layer. However, the epidermises not being composed of noticeably thickened walls and the stomata count of 240 per square millimeter rank this plant as characteristic of its environment.

In the stems of these species the comparative amounts of xylem are associated directly with the habit of each. The tall erect stems of *A. incarnata*, which commonly are more or less branched at the apex, demand considerable strength, which is supplied essentially by the more abundant xylem. *A. pumila* and *A. quadrifolia*, being more procumbent in habit, also have relatively less xylem. The fact that *A. incarnata* has a large amount of available water, with its above-ground parts exposed to excessive transpiration, would also place a demand on the habit of the plant for a greater volume of water-conducting tissue, such as the increased xylem, which is composed of large tracheal vessel and numerous tracheids.

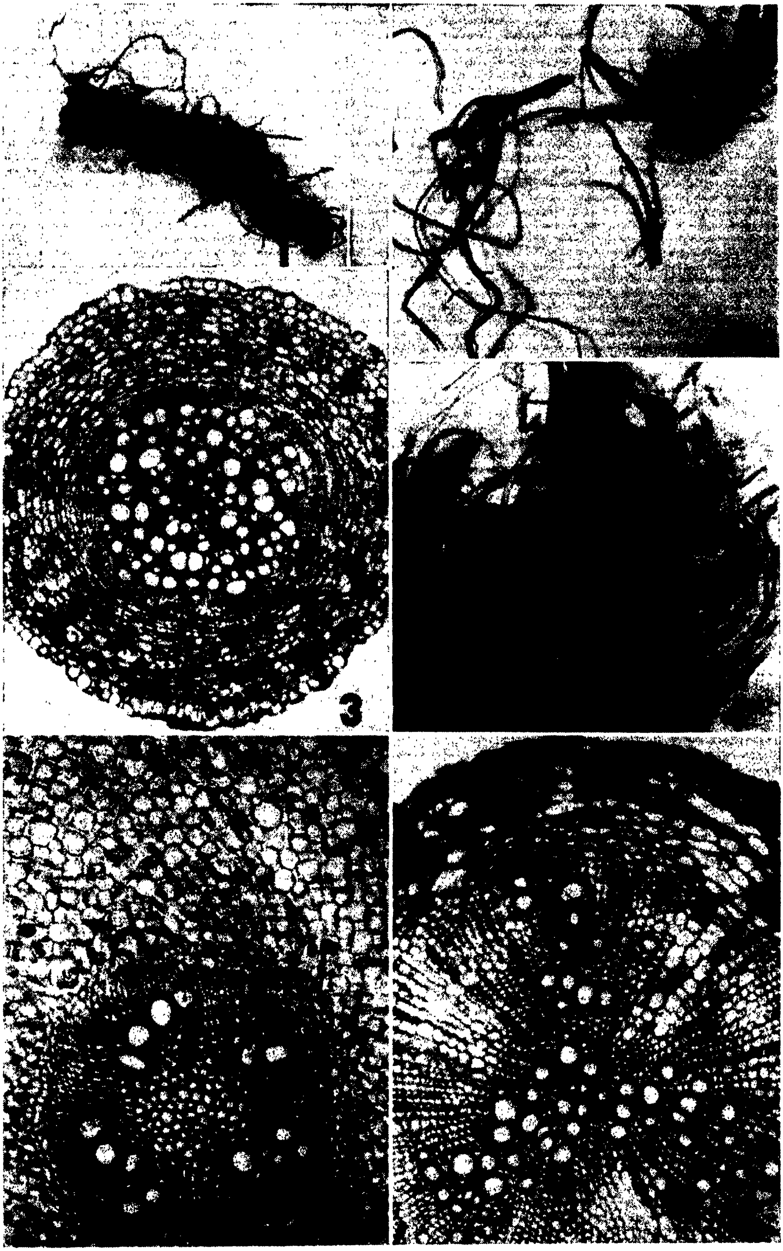
Although the root structure of the three species is quite different, the correlation with the varied habitats is less evident. The relative amounts of xylem for water conduction, as in the stems, show some relationship in this respect. The roots of *A. incarnata* and *A. pumila* have the greater proportion of their stele made up of tracheal vessels or tracheids as compared to *A. quadrifolia*. The stele of the roots of *A. quadrifolia* is composed of a larger proportion of xylem parenchyma.

FIGURES 1, 2, 3, 4, 5, 6

(Photomicrographs of Species of *Asclepias*)

FIG. 1. Rhizome of *A. quadrifolia.*
FIG. 2. Underground parts of *A. pumila.*
FIG. 3. Root cross section of *A. pumila.*
FIG. 4. Root system of *A. incarnata.*
FIG. 5. Root cross section of *A. incarnata.*
FIG. 6. Root cross section of *A. quadrifolia.*

FIGURES 1, 2, 3, 4, 5, 6

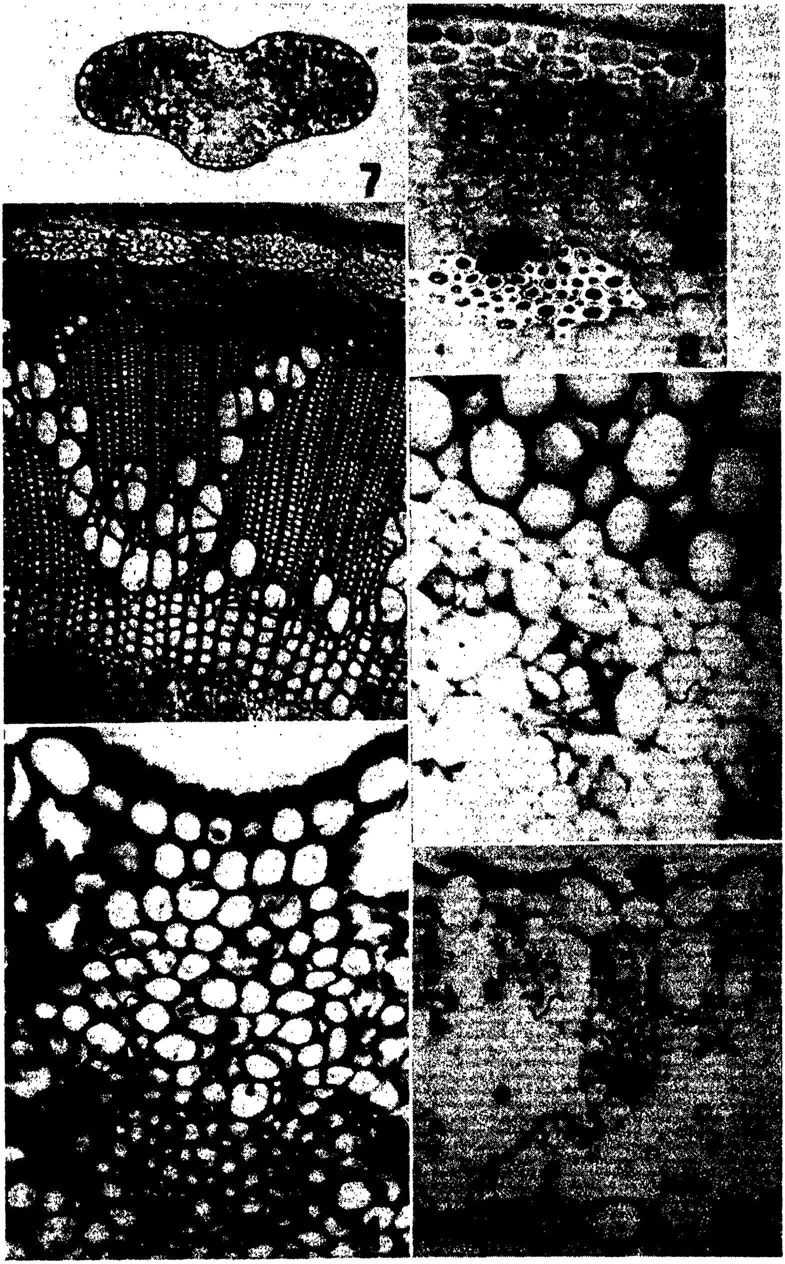


FIGURES 7, 8, 9, 10, 11, 12

(Photomicrographs of Species of *Asclepias*)

FIG. 7. Leaf cross section of *A. pumila*.
FIG. 8. Stem structure of *A. pumila*.
FIG. 9. Stem cross section of *A. incarnata*.
FIG. 10. Intraxylary phloem in stem of *A. incarnata*.
FIG. 11. Vascular arc in leaf of *A. pumila*.
FIG. 12. Leaf cross section of *A. quadrifolia*.

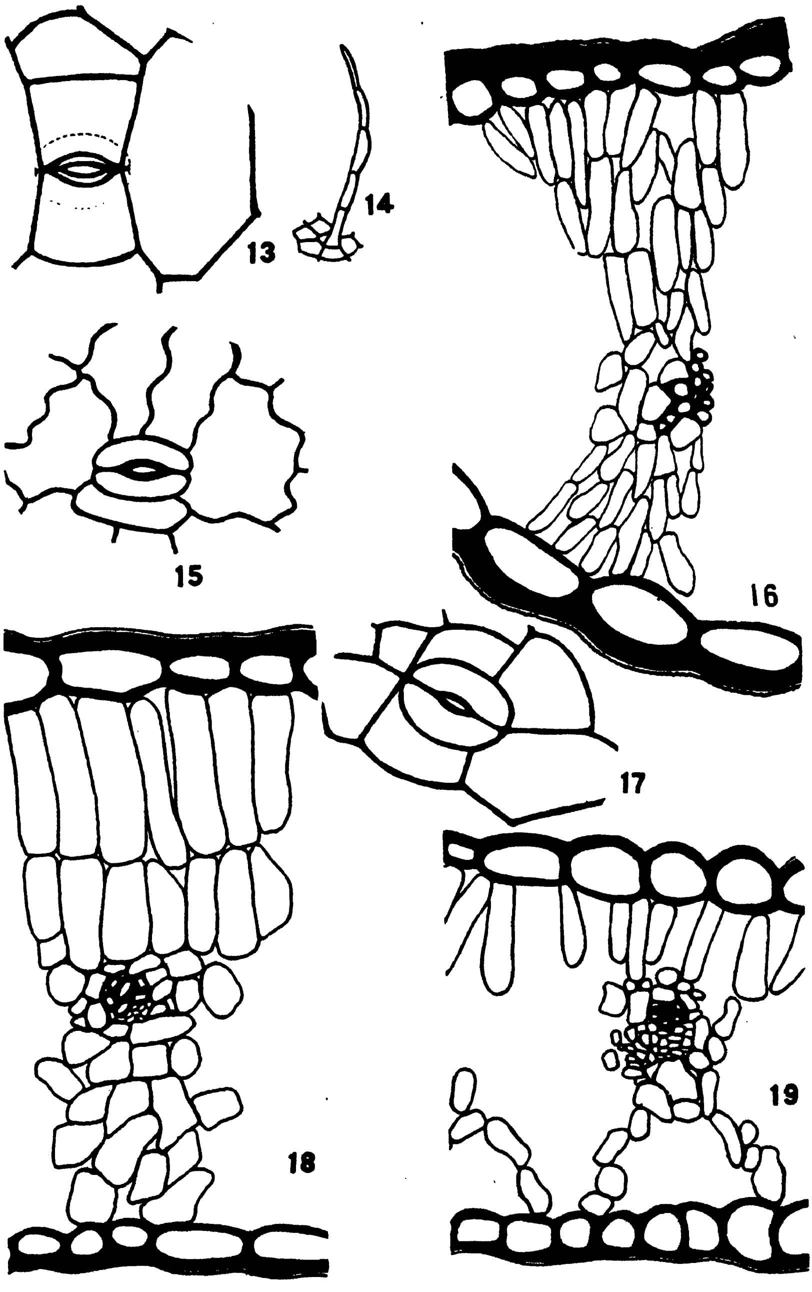
FIGURES 7, 8, 9, 10, 11, 12



FIGURES 13, 14, 15, 16, 17, 18, 19

FIG. 13. Epidermis and stoma of *A. incarnata*.
FIG. 14. Trichome from leaf of *A. incarnata*.
FIG. 15. Epidermis and stoma of *A. quadrifolia*.
FIG. 16. Leaf cross section of *A. pumila*.
FIG. 17. Epidermis and stoma of *A. pumila*.
FIG. 18. Leaf cross section of *A. incarnata*.
FIG. 19. Leaf cross section of *A. quadrifolia*.

FIGURES 13, 14, 15, 16, 17, 18, 19



Studies in Breaking the Rest Period of Grass Plants by Treatments With Potassium Thiocyanate and in Stimulating Growth With Artificial Light [1]

HAROLD R. SHEPHERD, Fort Hays Kansas State College, Hays, Kan.

INTRODUCTION

For several years there has been much interest in ecological pasture studies. This has necessarily placed emphasis upon the study of grasses, especially of their vegetative characters, since it is by these characters that closely grazed grasses must be identified. The government's attempt to control the dust storms in the Great Plains region by revegetation has aroused added interest in grass studies. This practical interest in grasses and the accompanying demand for men well trained in grass identification has made it desirable that college and university botany and agriculture classes study grasses in the fall and winter months. Since many grasses in the Great Plains region become dormant, dry, and sere in the fall and remain in this condition until spring it has been necessary to bring sods into the greenhouse and grow them for study. This has not proved very successful, since many grasses remain dormant for the greater part of the winter and will not grow even though given an artificial climate with optimums of temperature and light duration. If sods of grasses are given an optimum artificial climate after their rest periods have been broken by freezing weather they will produce enough vegetative growth for study. However, in exceptionally cold winters, if the ground has been frozen solidly it is often impossible to take up the sods, even though they would grow if placed in the greenhouse. Consequently, it has usually been late in the year before the vegetative characteristics of grasses could be satisfactorily studied.

There has developed a need for a practical means of artificially breaking the rest period and of stimulating the growth of grasses so that sods can be procured early in the fall before freezing weather, brought into the greenhouse, and forced early to make an abundant vegetative growth. This need suggested the study of which this paper is the report, namely, to discover whether or not the rest period of native grasses can be broken by treatment with potassium thiocyanate and their growth stimulated by artificial light supplemental to winter daylight.

RELATED STUDIES

Perhaps the most successful work on rest-period breaking is that done on potatoes and gladiolus by Denny and Miller. They have been successful in hastening the sprouting of dormant potato tubers by treatments with either potassium thiocyanate, sodium thiocyanate, ethylene dichloride, ethyl bromide, carbon bisulfide, trichloroethylene, ammonium thiocyanate, or ethyl iodide (1, 2, 3). Denny, working with Miller (4, 5), has also broken the rest period

---

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. A thesis submitted to the Graduate Division in partial fulfillment of the requirements for the degree of Master of Science.

of gladiolus cormels by treatment with ethylene chlorhydrin and by storage at low temperatures. Stanton and Denny (6) were successful in forcing some dormant woody plants with chemical vapors.

It has long been an established fact that growth and period of flowering of plants can be controlled by regulating the duration and intensity of the light they receive. Chief among the contemporary workers in photoperiodism are Garner and Allard of the United States Department of Agriculture. Garner (7) compared the responses of long-day and short-day plants to the relative length of day and night, and with Allard (8) he localized the response in plants to relative length of day and night. The same men (9) studied the duration of the flowerless condition of plants in response to unfavorable lengths of day.

Although experiments have been performed in the attempt to break the rest period of other plants by treatment with chemicals and to stimulate growth and hasten flowering of plants by regulation of light intensity and duration, little or no work of this nature has been done with grasses. Some photoperiodic experiments have been conducted on grasses by Weaver and Himmel (10), Emerson (11), and Evans (12). To the author's knowledge, however, no attempt has been made to break the rest period of grasses by chemical treatment.

MATERIALS AND METHODS

Obtaining the Sods

On October 13, 1937, sods of the following five kinds of grasses were cut to fit and were placed in 6-inch pots: blue grama grass (*Bouteloua gracilis*), buffalo grass (*Buchloe dactyloides*), tall or side oats grama grass (*Bouteloua curtipendula*), western wheat grass (*Agropyron smithii*), big bluestem grass (*Andropogon furcatus*). To save space, the sods for the pots were selected so that each contained grass plants of two different kinds. The grasses were potted together in the following combinations: buffalo grass with blue grama grass, tall grama grass with western wheat grass, and tall grama grass with big bluestem grass.

Care of Plants Before Treatment

The potted grasses were brought into the greenhouse and placed on a bench equipped with bottom heat. Here they were watered and their leaves were clipped to within about one inch of the surface of the soil.

To insure that the plants were in a state of dormancy, a period of 36 days was allowed to elapse between the time the plants were brought into the greenhouse and the time they were treated. During this interval the plants received water as needed, but were given no other treatment.

Treatment

On November 18, six sods of each kind of grass used in the experiment were treated with an aqueous solution of potassium thiocyanate (KSCN), of the following concentrations: 2.0 percent, 1.0 percent, 0.5 percent, 0.1 percent, 0.01 percent, and 0.001 percent. The solution was applied by pouring 200 c.c. about the crowns of the plants in each sod. This wet the soil in the pots to an average depth of five centimeters. Six sods of each kind of grass used in the experiment were left untreated as control plants.

After chemical treatment the sods were divided as to kind and number into two like series. One series is termed the "long-day" series; the other is designated the "short-day" series.

Plants in the long-day series were arranged in such a manner that they received artificial light supplemental to daylight from 300W-230V Mazda bulbs in reflectors 3 feet apart (13) suspended 22 inches above the pots (fig. 1). The lights were turned on at sundown each day and turned off at 11:30 p.m., giving an average day-length of 16 hours for the duration of the experiment. Plants in this series are termed "long-day" plants.

Plants in the short-day series were placed close to those in the long-day series and arranged under a frame in such a manner that they could be draped with a black sateen cloth which excluded nearly all light (fig. 1). These plants were allowed to receive only light of the normal winter-day duration. Plants in this series are termed "short-day" plants.

On December 30, after considerable freezing weather, sods of the kinds of grasses used in the experiment were obtained from out-of-doors. These were potted in the same manner as were those that received chemical treatment.

With the exception that the long-day series received light supplemental to daylight, both series received the same treatment. The plants were watered often enough with a hose spray to keep the soil moist. The average daily room temperature for the duration of the experiment was 72° F.

Detailed records were kept for each sod, notations being made of the date of resumption of growth after treatment, average height, vigor, density, and percentage survival.

RESULTS OF TREATMENT

Short Grasses

BLUE GRAMA GRASS

For the first two weeks before chemical treatment blue grama grass remained green, and in some cases made slight growth. However, before the end of the 36-day period prior to treatment the plants were yellow and in a dormant condition.

Twenty-one days after treatment, green leaves had pushed up through the culms of both short-day and long-day plants treated with potassium thiocyanate of 0.1 percent concentration (Table 1). In the short-day series, plants treated with a solution of 0.001 percent concentration also began growth 21 days after treatment. All concentrations of the solution except 2.0 percent and 1.0 percent initiated growth in plants so treated before growth began in the control plants. The control plants began growing 54 days after treatment, or 33 days after active growth began in the treated plants.

A 2.0 percent solution killed all plants so treated in both series (fig. 2). All long-day plants treated with a 1.0 percent solution were killed, and while this concentration did not completely kill the short-day plants it had a killing effect, as judged by percent survival and foliage appearance.

TABLE I.—Effect of potassium thiocyanate, supplemental light, and outdoor freezing upon blue grama grass

Treatment.	Effect of treatment: Averages.				
	Number of days after treatment until growth began.	Average height (cm.).		Percent survival.	Number of days after treatment until flowers appeared.
		95 days after treatment.	140 days after treatment.		
Long-day Series					
Control	54	27	37	96	139
2.0 percent KSCN	dead	dead	dead	dead	....
1.0 percent KSCN	dead	dead	dead	dead	....
0.5 percent KSCN	49	24	32	50	....
0.1 percent KSCN	21	27	61	95	....
0.01 percent KSCN	44	31	48	98	139
0.001 percent KSCN	44	29	52	98	139
Outdoor freezing	4*	29	61	98	139
Short-day Series					
Control	54	9	9	98	....
2.0 percent KSCN	dead	dead	dead	dead	....
1.0 percent KSCN	54	10	10	10	....
0.5 percent KSCN	49	12	12	50	86
0.1 percent KSCN	21	8	8	98	....
0.01 percent KSCN	49	15	15	98	....
0.001 percent KSCN	21	12	12	98	....
Outdoor freezing	4*	10	10	98	....

* Number of days after frozen plants were brought into the greenhouse on December 30 until growth began.

Nearly all concentrations of the solution except 2.0 and 1.0 percent stimulated plants to greater growth in height (fig. 2).

Chemical treatment did not hasten flowering with one exception; this was a short-day plant treated with a 0.5 percent concentration. It flowered 86 days after treatment; none of the short-day control plants flowered. Supplemental light induced flowering 139 days after treatment. Strong concentrations of the solution seemed to inhibit flowering. Frozen plants flowered at the same time as did the controls.

Plants which had been frozen began growth four days after having been brought inside on December 30; at the end of the experiment they had made as much growth as the treated plants had made (fig. 3).

BUFFALO GRASS

Buffalo grass remained green for about two weeks after it was brought into the greenhouse. Slight evidences of growth were observed in a few plants shortly after being brought indoors; however, before the end of the 36-day period prior to treatment, the leaves of the plants, in most instances, were yellow. After chemical treatment, all plants became dry and looked as if dead; at this time green tissue could be found only at the bases of the culms and stolons.

Reference to Table II shows that in no instance was the rest period broken by chemical treatment; chemically treated plants and control plants began growth 54 days after treatment.

All plants treated with 2.0 and 1.0 percent concentrations of the solution were killed.

Vegetative growth was greatly stimulated by supplemental light, long-day controls having grown more than twice as tall as short-day controls. In all but a few instances the solution stimulated growth.

Plants frozen out-of-doors began to grow four days after having been brought inside. At the end of the experiment they had not made as much growth as had the treated plants.

Chemical treatment seemed to inhibit flowering, for in both series the controls produced flowers as early as and more abundantly than did the chemically treated plants. Flowers appeared 81 days after treatment on both long-day and short-day controls. The flowering response to chemical treatment was very erratic; some long-day plants treated with 0.1 percent chemical flowered 81 days after treatment, while those treated with 0.01 percent chemical flowered 140 days after treatment. Short-day plants given a 0.01 percent concentration of the solution flowered 86 days after treatment.

TABLE II.—Effect of potassium thiocyanate, supplemental light, and outdoor freezing upon buffalo grass

TREATMENT.	Effect of treatment: Averages.				
	Number of days after treatment until growth began.	Average height (cm.). 95 days after treatment.	Average height (cm.). 140 days after treatment.	Percent survival.	Number of days after treatment until flowers appeared.
LONG-DAY SERIES					
Control	54	16	29	96	81
2.0 percent KSCN	dead	dead	dead	dead	dead
1.0 percent KSCN	dead	dead	dead	dead	dead
0.5 percent KSCN	54	11	17	62	....
0.1 percent KSCN	54	13	35	96	81
0.01 percent KSCN	54	20	34	98	140
0.001 percent KSCN	54	12	30	98	....
Outdoor freezing	4*	15	31	98	....
SHORT-DAY SERIES					
Control	54	12	12	98	81
2.0 percent KSCN	dead	dead	dead	dead	dead
1.0 percent KSCN	dead	dead	dead	dead	dead
0.5 percent KSCN	54	10	10	97	....
0.1 percent KSCN	54	11	11	98	....
0.01 percent KSCN	54	12	12	98	86
0.001 percent KSCN	54	11	11	98	....
Outdoor freezing	4*	9	9	98	....

* Number of days after plants were brought into the greenhouse on December 30 until growth began.

TALL GRASSES

TALL OR SIDE OATS GRAMA GRASS

Tall grama grass, prior to treatment, reacted much as did the short grasses. It remained green for several weeks, making little or no growth and gradually becoming light green and then yellow in color until at the time of treatment the plants were dormant and sere.

Twenty-one days after treatment, green leaves were observed to be bursting from the sides of the dead culms of some plants and protruding up through them (Table III). As figure 4 shows, this response to chemical treatment was very erratic; 2.0 percent, 1.0 percent, 0.1 percent, and 0.001 percent concentrations were effective in breaking the rest period in long-day plants, while 2.0 percent, and 0.01 percent concentrations broke the rest period in the short-day plants. The long-day control plants began growth 69 days after treatment. Only one concentration failed to break the rest period in at least one series; this was a 0.5 percent concentration. Frozen plants resumed growth four days after they were brought indoors.

TABLE III.—Effect of potassium thiocyanate, supplemental light, and outdoor freezing upon tall or sideoats grama grass

Treatment.	Effect of treatment: Averages.			
	Number of days after treatment until growth began.	Average height (cm.).		Percent survival.
		95 days after treatment.	140 days after treatment.	
Long-day Series				
Control	69	4	12	65
2.0 percent KSCN	21	14	31	25
1.0 percent KSCN	21	14	37	50
0.5 percent KSCN	53	19	32	50
0.1 percent KSCN	21	26	22	55
0.01 percent KSCN	69	20	30	75
0.001 percent KSCN	21	17	36	50
Outdoor freezing	4*	31	45	98
Short-day Series				
Control	54	9	9	52
2.0 percent KSCN	21	12	12	5
1.0 percent KSCN	54	14	14	45
0.5 percent KSCN	54	15	15	50
0.1 percent KSCN	54	14	14	65
0.01 percent KSCN	21	14	14	60
0.001 percent KSCN	62	10	10	85
Outdoor freezing	4*	13	13	95

* Number of days after frozen plants were brought into the greenhouse on December 30 until growth began.

Growth was greatly stimulated in both short- and long-day plants by chemical treatment (fig. 5). Supplemental light alone stimulated growth only a little; the combined action of the chemical and supplemental light produced nearly three times as much growth as did chemical alone (fig. 5).

While concentrations of chemical most effective in breaking the rest period induced, on the average, slightly greater growth than did other concentrations, in most instances they had a killing effect as judged by percentage survival and foliage appearance. In the long-day series, plants which had been frozen produced more growth than did those that were treated with the solution.

WESTERN WHEAT GRASS

Western wheat grass was green and growing when first placed in the greenhouse. Unlike the other grasses it did not become yellow and cease growing during the 36-day period before treatment, but grew rapidly. After treatment, both long-day and short-day plants treated with the solutions of 2.0 percent and 1.0 percent concentrations died (figs. 6, 7). All other plants continued growth without interruption for the duration of the experiment (Table IV). Plants frozen out-of-doors began growth four days after having been brought indoors.

Supplemental light greatly stimulated growth; long-day control plants produced more than twice as much growth as did the short-day controls (fig. 8).

Plants which received both chemical treatment and supplemental light produced two times as much growth as did plants which received only supplemental light (fig. 9). In the short-day series, frozen plants and chemically treated plants made approximately the same amount of growth.

No plants flowered during the experiment.

TABLE IV.—Effect of potassium thiocyanate, supplemental light, and outdoor freezing upon western wheat grass

Treatment.	Effect of treatment: Averages.			
	Number of days after treatment until growth began.	Average height (cm.). 95 days after treatment.	Average height (cm.). 140 days after treatment.	Percent survival.
Long-day Series				
Control	1	23	37	98
2.0 percent KSCN	dead	dead	dead	...
1.0 percent KSCN	dead	dead	dead	...
0.5 percent KSCN	1	13	30	1
0.1 percent KSCN	1	38	47	98
0.01 percent KSCN	1	36	47	74
0.001 percent KSCN	1	39	48	98
Outdoor freezing	4*	32	46	98
Short-day Series				
Control	1	16	16	98
2.0 percent KSCN	dead	dead	dead	...
1.0 percent KSCN	dead	dead	dead	...
0.5 percent KSCN	1	11	11	65
0.1 percent KSCN	1	13	13	98
0.01 percent KSCN	1	17	17	98
0.001 percent KSCN	1	16	16	98
Outdoor freezing	4*	18	18	98

* Number of days after plants were brought into the greenhouse on December 30 until growth began.

BIG BLUESTEM GRASS

Big bluestem grass remained green only a short time after having been placed in the greenhouse. It did not produce any growth prior to treatment, but gradually became red and sere, until 69 days after treatment it was considered dead. At this time, sprouts were observed to be protruding from the crown of some of the sods (Table V). The long-day and short-day controls

began growth 81 and 75 days, respectively, after treatment. With the exception of the 2.0 percent concentration, which had a killing effect, all concentrations of chemical produced a slight initiating response. Frozen plants in long- and short-day series resumed growth 22 and 8 days, respectively, after having been brought indoors.

Neither supplemental light nor chemical treatment when acting alone stimulated growth perceptibly. Supplemental light, acting together with chemical treatment, however, induced twice as much growth as did chemical treatment alone. Frozen plants in the long-day series did not produce as much growth as did chemically treated plants. Frozen plants in the short-day series and plants that had received chemical treatment produced approximately the same amount of growth, but frozen plants produced more growth than those given no treatment at all.

No big bluestem plants flowered during the experiment.

TABLE V.—Effect of potassium thiocyanate, supplemental light, and outdoor freezing upon big bluestem grass

Treatment.	Effect of treatment: Averages.			
	Number of days after treatment until growth began.	Average height (cm.). 95 days after treatment.	Average height (cm.). 140 days after treatment.	Percent survival.
Long-day Series				
Control	81	11	20	98
2.0 percent KSCN	81	14	20	1
1.0 percent KSCN	69	22	35	25
0.5 percent KSCN	69	16	32	50
0.1 percent KSCN	69	23	40	90
0.01 percent KSCN	69	8	8	1
0.001 percent KSCN	69	24	26	1
Outdoor freezing	22*	16	33	98
Short-day Series				
Control	75	15	15	95
2.0 percent KSCN	dead	dead	dead	....
1.0 percent KSCN	69	14	14	20
0.5 percent KSCN	69	15	15	60
0.1 percent KSCN	69	17	17	75
0.01 percent KSCN	69	16	16	50
0.001 percent KSCN	69	12	12	2
Outdoor freezing	8*	17	17	98

* Number of days after plants were brought into the greenhouse on December 30 until growth began.

Results in General

Although nearly all concentrations of the solution were effective to some degree in breaking the rest period of blue grama grass, tall or side oats grama grass, and big bluestem grass, the concentrations most effective ranged below 0.5 percent. Concentrations of 0.5 percent and greater, while effective, in some instances of breaking the rest period, usually had a killing effect. The plants which received strong chemical treatment had the tips of their leaves burned

by the chemical. Although some plants in tall grama grass sods treated with 1.0 and 2.0 percent concentrations of chemical began growing early and made much growth, many of the plants in the sods were killed (Table III).

In all instances, grasses treated with chemical were lighter green in color than were untreated plants. This was most noticeable in western wheat grass which showed very pronounced color variations due to differences in solution concentrations.

Weak concentrations of solution, even though they did not break the rest period, stimulated growth. This was especially noticeable in buffalo grass plants which received illumination supplemental to daylight (Table II). Chemical treatment had no effect on the number of stolons produced, but it did stimulate growth in length of stolons.

Supplemental illumination in all instances was very effective in stimulating vegetative growth. Plants in the long-day series, as contrasted with those in the short-day series, were in general more vigorous. The leaves and stems were narrower and lighter in color, and there was less pubescence on grasses where normally it is present. This agrees with the findings of Popp (14), and of Ramaley (15). Long-day plants, in accord with the findings of Weaver and Himmel (10), developed more extensive root systems than did short-day plants.

Chemical treatment did not induce flowering, for the control plants in both series flowered more profusely than did treated plants. Long-day treatment stimulated flowering in blue grama grass. Perhaps a day length intermediate between that given the two series would have induced flowering in tall grama grass and western wheat grass [Evans and Allard (12), Emerson (11)].

Plants late to begin growing grew rapidly and by the end of the experiment had produced as much growth as had those that began growing earlier. This was especially true of plants which had received out-of-door freezing.

SUMMARY

Some sods of five mid-western grasses were treated with potassium thiocyanate, some subjected to out-door freezing, and then some of each of these were given light supplemental to daylight in the attempt to break their rest period and to stimulate growth.

The rest period of blue grama grass and tall or sideoats grama grass was effectively broken 21 days after treatment with solutions of potassium thiocyanate. A slight initiating response was caused also in big bluestem grass by chemical treatment. The most effective strength of solution was a 0.1 percent concentration.

Chemical treatment was not effective in breaking the rest period of buffalo grass; chemically treated and control plants began growth 130 days after having been brought indoors, or 54 days after treatment.

Western wheat grass appears to have no rest period; it began growth immediately upon being brought indoors, and continued growing for the duration of the experiment.

In most instances, chemical and supplemental light stimulated growth in height.

In the majority of cases 2.0 and 1.0 percent concentrations of chemical killed plants so treated.

Chemical treatment seemed to inhibit flowering of buffalo grass. Supplemental light was conducive to the flowering of blue grama grass.

Plants of all grasses frozen out-of-doors began active growth four days after having been brought indoors on December 30; in nearly all instances they had made as much growth by the end of the experiment as had the treated plants.

ACKNOWLEDGMENTS

The author owes a debt of gratitude to Dr. F. W. Albertson in suggesting the problem for this paper, for help during the experiment, and for criticizing and reading the manuscript. The author also wishes to sincerely thank Dr. L. D. Wooster and Dr. A. W. Barton, who so kindly permitted him the use of their photographic equipment and supplies. He sincerely appreciates his wife's help in recording observations, and Dr. F. B. Streeter's advice in preparation of the manuscript. Thanks are also due Mr. Jack Eades and Mr. Marvin Lacey, who assisted in caring for the plants.

LITERATURE CITED

1. DENNY, F. E. Chemical changes induced in potato tubers by treatments that break the rest period. Amer. Jour. of Bot. 16: 326-337. 1929.

2. DENNY, F. E., and LAWRENCE P. MILLER. Further experiments on shortening the rest period of potato tubers. Contributions from Boyce Thompson Inst. 7: 157-181. 1935.

3. MILLER, LAWRENCE P., and F. E. DENNY. Relation between quantity of ethylene chlorhydrin absorbed and growth response in treatments for shortening the rest period of potato tubers. Contributions from Boyce Thompson Inst. 8: 121-136. 1936.

4. DENNY, F. E. Shortening the rest period of gladiolus by treatment with chemicals. Am. Jour. of Bot. 17: 602-613. 1930.

5. DENNY, F. E., and LAWRENCE P. MILLER. Hastening the germination of dormant gladiolus cormels with vapors of ethylene chlorhydrin. Contributions from Boyce Thompson Inst. 6: 31-38. 1934.

6. STANTON, E. N., and F. E. DENNY. Forcing dormant woody plants with chemical vapors. Florists Exchange and Hort. Trade World. 70: 11, 15, 36. 1929.

7. GARNER, W. W. Comparative responses of long-day and short-day plants to relative length of day and night. Plant Physiology. 8: 347-356. 1932.

8. GARNER, W. W., and H. A. ALLARD. Localization of the response in plants to relative length of day and night. Jour. of Agri. Research. 31: 555-566. 1925.

9. ——— Duration of the flowerless condition of some plants in response to unfavorable lengths of day. Jour. of Agri. Research. 43: 439-443. 1931.

10. WEAVER, J. E., and W. J. HIMMEL. Relation between the development of root system and shoot under long-day and short-day illumination. Plant Physiology. 4: 435-457. 1929.

11. EMERSON, R. A. Control of flowering in teosinte. Journal of Heredity. 15: 41-48. 1924.

12. EVANS, MORGAN W., and H. A. ALLARD. Relation of length of day to growth of timothy. Jour. of Agri. Research. 48: 571-586. 1934.

13. LAURIE, ALEX, and G. H. POESCH. Photoperiodism—the value of supplementary illumination and reduction of light on flowering plants in the greenhouse. Wooster, Ohio, Agri. Exp. Sta. Bull. 512. 1932.

14. POPP, W. HENRY. Effect of light intensity on growth of soybeans and its relation to the autocatalyst theory of growth. Bot. Gaz. 82: 306-319. 1926.

15. RAMALEY, FRANCIS. Influence of supplemental light on blooming. Bot. Gaz. 96: 165-174. 1937.

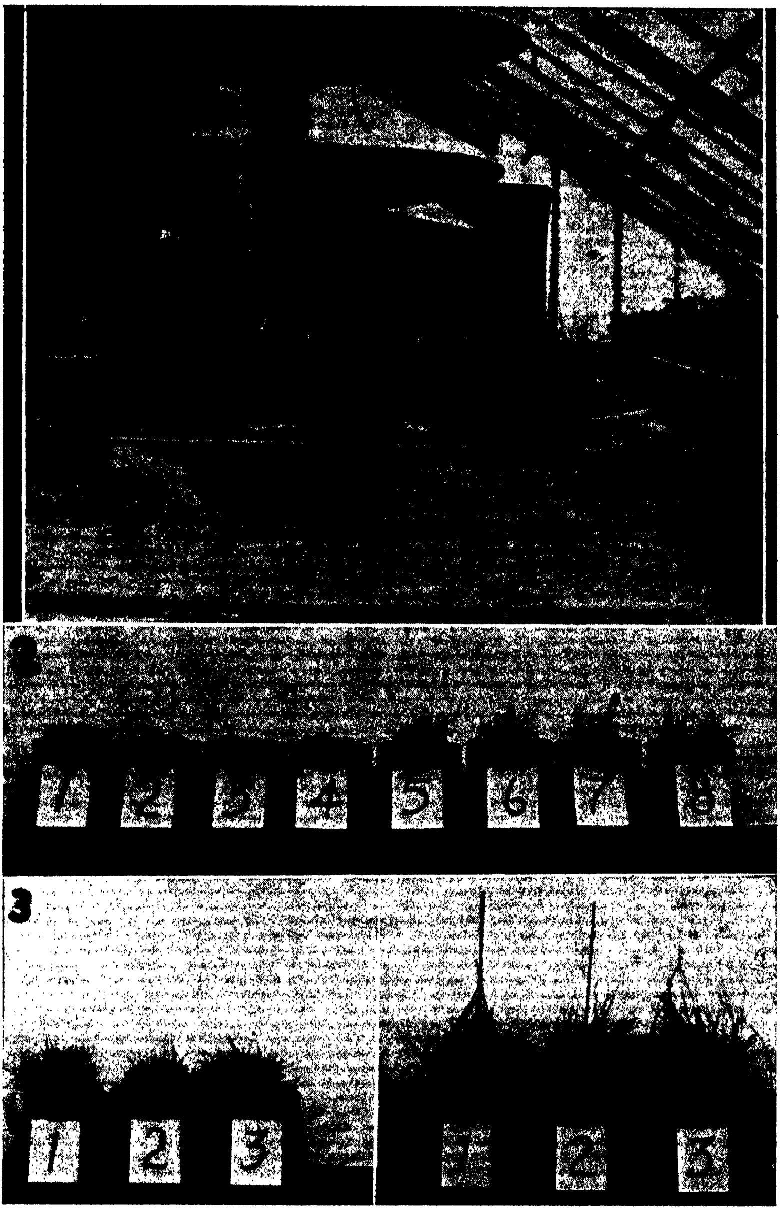
FIGURES 1, 2, 3

FIG. 1. *Photograph of Equipment.* Long-day series under lights in foreground. Short-day series under shading-frame in background.

FIG. 2. *Blue Grama Grass.* Short-day series. Shows killing effect of 1.0 percent and 2.0 percent solutions. Photograph taken 54 days after treatment. (1) Control, (2) 2.0 percent, (3) 1.0 percent, (4) 0.5 percent, (5) 0.1 percent, (6) 0.01 percent, (7) 0.001 percent, (8) frozen.

FIG. 3. *Blue Grama Grass.* To the left short-day series, to the right long-day series. Photograph taken 95 days after treatment. (1) Control, (2) 0.1 percent, (3) frozen.

FIGURES 1, 2, 3



FIGURES 4, 5, 6, 7, 8, 9

FIG. 4. *Tall or Sideoats Grama Grass:* Long-day series showing erratic response to chemical treatment. Photograph taken 54 days after treatment. (1) Control, (2) 2.0 percent, (3) 1.0 percent, (4) 0.5 percent, (5) 0.1 percent, (6) 0.1 percent, (7) 0.001 percent, (8) frozen.

FIG. 5. *Tall or Sideoats Grama Grass:* Photograph taken 95 days after treatment, showing stimulating effect of chemical treatment and supplemental light. Short-day: (1) Control, (2) 0.1 percent. Long-day: (3) Control, (4) 0.1 percent.

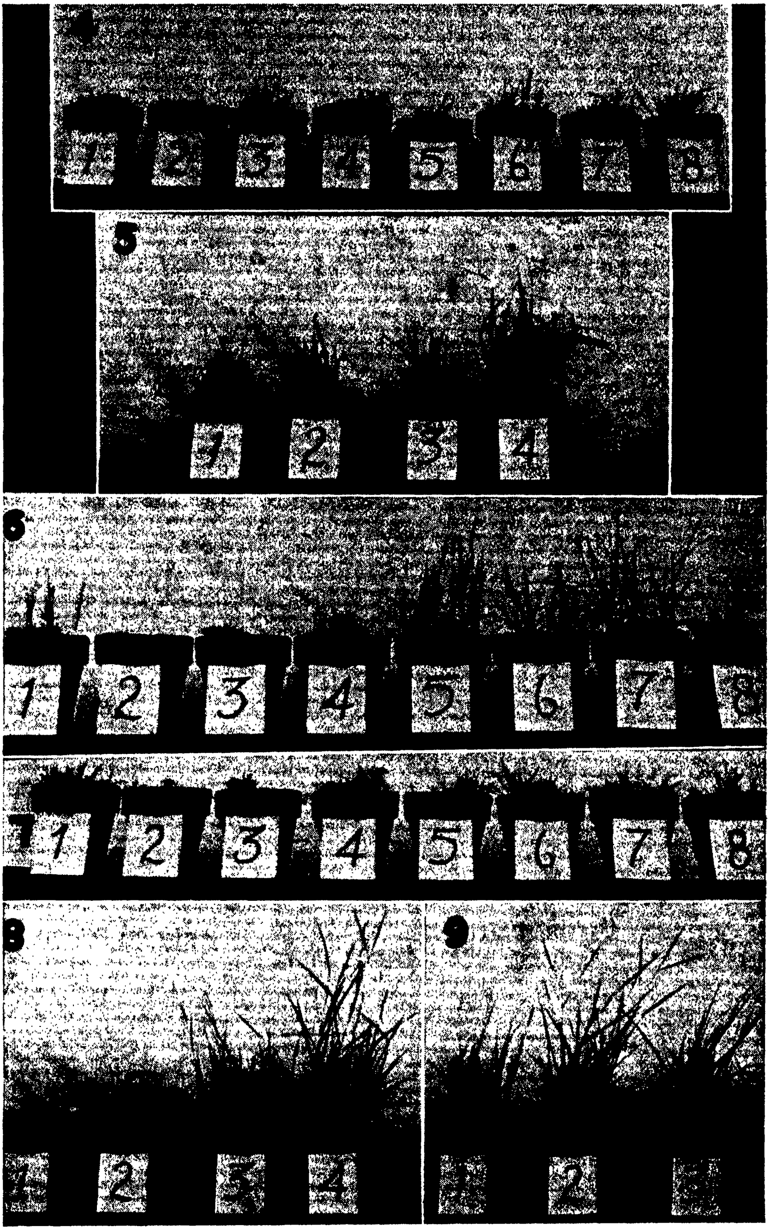
FIG. 6. *Western Wheat Grass:* Long-day series. Photograph taken 54 days after treatment, showing the killing effect of 2.0 and 1.0 percent solutions. (1) Control, (2) 2.0 percent, (3) 1.0 percent, (4) 0.5 percent, (5) 0.1 percent, (6) 0.01 percent, (7) 0.001 percent, (8) frozen.

FIG. 7. *Western Wheat Grass:* Short-day series. Photograph taken 54 days after treatment, showing the killing effect of 2.0 and 1.0 percent solutions. (1) Control, (2) 2.0 percent, (3) 1.0 percent, (4) 0.5 percent, (5) 0.1 percent, (6) 0.01 percent, (7) 0.001 percent, (8) frozen.

FIG. 8. *Western Wheat Grass:* Photograph taken 95 days after treatment, showing the stimulating effect of chemical treatment and supplemental light. Short-day: (1) Control, (2) 0.001 percent. Long-day: (3) Control, (4) 0.001 percent.

FIG. 9. *Western Wheat Grass:* Photograph taken 95 days after treatment, showing contrast of effect of chemical treatment and freezing upon growth in long-day series. (1) Control, (2) 0.001 percent, (3) frozen.

FIGURES 4, 5, 6, 7, 8, 9



Eryngium yuccifolium: Ecological Distribution and Some Morphological Irregularities

J. A. TRENT, Kansas State Teachers College, Pittsburg, Kan.

INTRODUCTION

The genus *Eryngium* is a rather diversified one, containing both parallel- and net-veined species, and consisting of over 1,700 species of wide geographic distribution in the tropics and temperate regions. The species under consideration in this paper is a parallel-veined one, *Eryngium yuccifolium* Michx. (*E. aquaticum L.*), commonly known in various localities as rattlesnake master, corn snakeroot, button snakeroot, etc. It is the writer's purpose to present the results of his studies on *Eryngium yuccifolium* as to its ecological distribution, early and present-day distribution, and some of its morphological and anatomical irregularities.

ECOLOGICAL DISTRIBUTION

Early Distribution. The parallel-veined Eryngiums are primarily American, and have been known since early in the eighteenth century (9) when *Eryngium aquaticum* L. was reported by D. J. Banister (3, 9) of Virginia. Banister named the plant the field eryngium and described it as having yucca-like leaves, with small, tender spines on the margins. Seeds of the specimen were sent to England and from them plants were grown in the gardens at Oxford University, and described by Robert Morrison as *Eryngium virginianum,* with yucca-like leaves, spines set on the margins, etc. (E. virginianum yucca foliis, spinulus raris tenellis et inutilibus marginibus appositis). Morrison thought the plant might well be placed in the same genus with yucca. Ph. Miller (8) described the plant more in detail, and likewise compared the leaves with those of yucca and aloe. In 1853 Linneaus (7) characterized the plant as *Eryngium aquaticum,* at which time he described the leaves as having the appearance of the smaller Bromelia, but ciliate, with tender, flexible hairlike spines. (E. aquaticum. Facies et folia Bromeliae minoris, sed haec ciliata spinis capillaribus flexilibus mitibus.) This description only in part characterizes the plant under consideration. John Clayton (3), in his Flora Virginica, listed several of the "yuccalike" leaved species of Eryngium found in Virginia in the early days. This list was compiled in part from Linnaeus Species Plantarum of 1753; Linn., Hortus Cliffortianus, Amstel 1737; Banister's list in Ray's Historia Plantarum, 1704; Leonardi Pluckneti Almagistrum Botanicum, London, 1696; and Historia Plantarum Universalis, Robert Morrison, 1679. The plant collected and described by Banister was most likely from the coastal plains of Virginia, as one would think that most of the collecting done in Virgina in the early days would have been done near the coast. *Eryngium yuccifolium* is still growing in Princess Anne and Norfolk counties in Virginia, which are in the coastal plain region, and it would appear reason-

Trans. Kansas Acad. Science, Vol. 41, 1938.

able that Banister might have collected in one of those counties. Andre Michaux, the French botanist, named the plant *Eryngium yuccifolium* in 1803. This plant may have reached the coastal plains of Virginia from the west when the prairies extended along the coast, even to Virginia and much farther north. De Caisne (4) thought that the plant might have reached the North American continent from South America when there were still land connections between the two continents.

EARLY DISTRIBUTION IN CENTRAL OHIO. In 1925 portions of the leaves of *Eryngium yuccifolium* were unearthed, along with an Indian mummy, from a rock shelter (Kettle Hill cave) in Fairfield county, Ohio, about three miles south of the city of Lancaster. The leaves were twisted into a rope-like braided cord (fig. 2), indicating that the Indians must have used it quite extensively for its fiber. The determinations were made by Professor John H. Schaffner, of Ohio State University. He recognized the plant by the presence of the spines on the margins of the leaves which are characteristic of the plant. Figure 4 shows a vascular bundle and sclerenchyma sheath of the prehistoric specimen, and figure 5 is a section of a leaf collected by the writer in the Kettle Hill region in the summer of 1937. A comparison of the two sketches, it seems, confirms Professor Schaffner's determination. They are doubtless the same species. The plant must have been more plentiful at that time than it is today in that region. The writer collected the plant within a few hundred yards of the rock shelter, in the summer of 1937, and found it very sparsely distributed. The time at which these Indians lived is not known definitely; however, according to Shetrone (11), the occupants of the rock shelters of southern Ohio (Kettle Hill being one of them) were the Algonquain tribesmen of pre-Columbian and proto-historic times. (Incidentally the glacier extended just to Lancaster in Ohio.) Figure 3 shows a stand of *Eryngium yuccifolium* growing in Jackson county, Ohio, in 1937.

PRESENT DISTRIBUTION. The map (fig. 1) shows the present distribution of *Eryngium yuccifolium* in the United States, by counties (2, 10, 12). It is at once observed that the plant is found in every state east of about the 98th meridian, with the exception of Pennsylvania, West Virginia, New York, Vermont, New Hampshire, Maine, Rhode Island, Massachusetts, and Delaware. Doubtless it might be found in some of these states should they be thoroughly worked. The counties checked are those from which the plant has been definitely reported, and specimens are now in herbaria of the various states or elsewhere. From the distribution map it is seen that its western limit is almost a straight line, near the 98th meridian, from the south to the north, and is reported at no place west of that line. Incidentally, about the 98th meridian marks the western boundary of the prairies proper. This is also a rather distinct line at which the nature of the soil and the amount and nature of precipitation change. The most easterly station from which the plant is reported is near Bidgeport, Conn., where botanists at Yale University think it probably native. The line indicates its range in Texas. County distribution was not available except for a few counties. Likewise, no county records were available for South Dakota. Its distribution appears to be fairly common on the coastal plains, from Louisiana to Connecticut. There is evidence that it is found in eastern North Carolina, but no county records were available. Personal correspondence with botanists in the various states

has indicated that the plant is more widespread than indicated by the map, especially in Arkansas, Missouri, Georgia, Louisiana, Alabama, and Florida. No doubt more complete collecting would reveal a more widespread distribution in many of the other states, and possibly its presence in some other states from which no reports have been made. While the plant is found in other than prairie habitats, its best development is found on the prairies. Most likely there are at present prairie remnants, or have been prairie areas, in all of the states in which it is now found growing. Its presence today in Ohio is only in prairie patches. Transeau (14) has shown that the presence of deep prairyerths of both upland and lowland types testify to the long continued occupancy of prairie vegetation as far east as central Ohio, and that relict communities of prairie plants in Ohio are now confined mostly to areas known to have been prairie when the lands were settled a century ago. Furthermore, he (Transeau) has shown that the climax of the prairie peninsula in Ohio is just as typical as that of the prairies proper farther to the west. The present distribution of *Eryngium yuccifolium* as shown on the distribution map correlates, in the main, with the prairie peninsula as indicated by Transeau.

In his study of the prairie flora of Dane county, Wisconsin, Gould (6) has shown that there has been almost no migration of *Eryngium yuccifolium* from the original prairie areas. The plant is now found in thirty-two localities in Dane county, thirty of which are confined to the original prairies.

As was indicated above, *Eryngium yuccifolium* is found in various habitats, but its best development is on prairie soils. In Louisiana it occurs widely distributed in nonprairie soils; in South Dakota it occurs in wet soils along the Big Sioux river; in the Everglades of Florida; and generally along the coastal plains. Other habitats are open upland woods, rocky slopes in openings, and along railroad rights-of-way, old roads, ditches, and in meadows, waste places, etc. Fassett (5) indicates that it may have been introduced as a weed in Washburn county, Wisconsin, where it is found along an old road, and probably was brought in with hay. It is at once apparent from the distribution map that Washburn county is considerably north of the center of its present distribution in Wisconsin.

Factors Limiting its Distribution. It appears most likely that soil acidity is one of the limiting factors in the distribution of *Eryngium yuccifolium.* The plant is found growing in soils which are slightly acid. There are doubtless other factors limiting its distribution.

Natural Succession. Steyermark (13), speaking of the Missouri and Arkansas Ozarks, says that the place of *Eryngium yuccifolium* in natural succession appears to be first on the prairies and glades. Later the forest (oak-hickory association) encroaches upon these habitats, which accounts for the presence of the Eryngium in the open, rocky woods. He describes the prairie and glade associes as being developmental associes of the oak-hickory climax.

SOME MORPHOLOGICAL AND ANATOMICAL CHARACTERISTICS

Although *Eryngium yuccifolium* is a dicotyledonous plant (of the *Umbelliferae* family), it has some characteristics, grossly at least, in common with monocotyledonous plants, the most noticeable of which is the apparent parallel venation of the leaves. Anatomically the venation has more in com-

mon with the manner of veining found in dicotyledonous plants than it does with the typical monocotyledonous method of veining. Many of these anomalies were observed by Möbius (9) and other early workers. Figure 6 shows a longitudinal section through three young leaves as they begin growth from the meristematic region of the rhizome. The youngest leaf, which is some 30 microns from the rhizome, shows the bundles to be parallel as they enter the leaf. Some cross veins are being formed in the second leaf some 500 microns from the meristematic region of the rhizome. Distinct cross veining is observed in the oldest leaf, which is a fraction over a millimeter from the rhizome. Although there are cross veins in monocotyledonous leaves, they are much smaller than the main veins, which run parallel. It is very apparent in the leaves of this species that the cross veins are practically as heavy, if not just as much so, as in the young leaves. Figure 10 shows the manner of veining in a complete leaf one centimeter in length. The leaf was cleared with phenol, and the drawing was made by use of the low power of the microscope. It shows the same characteristics in veining as in figure 6. The anastomoses are very common and the cross veins are still almost as prominent as the parallel ones. No spines have yet appeared. All upright veins run to the tip of the leaf, which is characteristic of monocotyledonous leaves. Additional veins have been formed through the activity of the intercalary meristem. There are eleven upright veins in this particular leaf. The outer two lines represent the sclerenchyma layers on the margins.

Figure 7 represents the vascular system of the lower two-centimeter portion of a 15-centimeter leaf drawn under a dissecting-microscope of 20 diameters after being cleared with phenol. The veining here is still characteristic of that of the one-centimeter leaf, the anastomoses being frequent and large. Ten parallel veins are present in this portion of the leaf. Figure 8 shows a two-centimeter portion taken from about the center of the same leaf and treated in the same manner as in figure 7. Here it is observed that many smaller veins are coming in between the larger ones. The spines are present at this level and it is at once observed that they are in each case connected directly with the vascular system. Such is not the case with yucca, the leaf with which comparisons are frequently made. The marginal threadlike fibers in yucca are distinctly epidermal in origin (fig. 15). The writer is inclined to agree with Möbius (9) that the spines are modfied leaves or leaf lobes. De Caisne (4, 9) believed the parallel-veined species to be of later origin than those with dissected leaves. Figure 9 shows the upper two-centimeter portion of the same leaf. The spines are much more numerous at this level.

Figure 11 shows an entire ten-centimeter leaf bract taken from well up the stem. It is shown here that the anastomosing is very pronounced and the spines are numerous. Figure 12 shows the method of veining in detail. This is taken from a prepared slide of a longitudinal section cut parallel to the lamina, from the upper third portion of a five-centimeter leaf. The high power of the microscope was used in making this drawing. This method of vein formation is more comparable with the dicotyledonous manner of veining than with the monocotyledonous manner of veining. Lateral projections of the main parallel veins arise, meet, anastomose and then grow parallel to the older veins. This sketch in detail shows the large anastomosing which is characteristic of this leaf and dicotyledonous leaves in general. In the mono-

cotyledonous plants, the cross veins are found only occasionally and much smaller than the parallel veins. The leaf of *Eryngium yuccifolium* has no midrib, which is characteristic of the monocotyledonous leaves, grass leaves in particular, but comparable to grass leaves in having sclerenchyma layers on both sides of the leaf above and below the vascular bundles (fig. 5, which was taken from about the middle of a 70-cm. leaf). Oftimes there are two vascular bundles, one directly above the other, and these, with the sclerenchyma layers, make a continuous layer of hard tissue from the dorsal to the ventral side of the leaf. The intervascular tissue is destroyed early by the formation of large air channels. Oil ducts accompany the vascular bundles and are characteristic of the areial stems as well.

MANNER OF GROWTH. The method of growth of the leaves of *Eryngium yuccifolium* is another anomaly. Figures 13 and 14 show diagrammatically the method of growth in the young leaf. Figure 13 shows a five-centimeter leaf which was marked in as near five-millimeter squares as possible, and figure 14 shows the same leaf ten days later. The leaf has doubled in length, but the squares have remained almost the same size. Of course, there is some spreading of the leaf through the activity of the intercalary meristem, as the mature leaf often attains a width of more than one inch. This method of growth is more characteristic of that typical of grasses and other monocotyledonous plants, and is quite unlike that typical of the dicotyledonous plants. Avery (1) has shown that the growth in the dicotyledonous leaf, *Nicotiana tabacum* L., that growth is more pronounced in the central and basal portions of the leaf than toward the distal end. In *Eryngium yuccifolium,* as Avery observed in tobacco, the apical portion of the leaf matures early; however, in Eryngium, growth of the leaves is almost entirely basal. The stomata in the young leaves at first are lined up in rows typical of the grass type, but as the leaf matures they become irregularly arranged, which is more of the dicotyledonous manner of arrangement.

SUMMARY

1. The genus Eryngium is a diversified one, consisting of both parallel- and net-veined species. The parallel-veined species are chiefly American.

2. Portions of the leaves of *Eryngium yuccifolium,* twisted into a ropelike braided cord, were unearthed from a rock shelter in Kettle Hill cave, in Fairfield county, Ohio, along with an Indian mummy, in 1925.

3. *Eryngium yuccifolium,* probably first collected by Banister on the coastal plain of Virginia, is at present reported from virtually every state from the 98th meridian to western Connecticut. It grows principally on the prairie and on the coastal plain, best in slightly acid soils.

4. *Eryngium yuccifolium* presents several morphological and anatomical anomalies, some of which have already been reported. It has characteristics in common, apparently at least, with both dicotyledonous and monocotyledonous plants. The manner of venation appears to resemble the dicotyledonous mode of branching more than that of the monocotyledons, although apparently it is parallel-veined. The anastomoses are much more frequent and more pronounced than in the grass-type leaf. The presence of the sclerenchyma layers, in connection with the vascular bundles and the basal growth of the leaves, is more characteristic of the grass-like leaf, however. The spines on the margins of the leaves are direct outgrowths of the vascular system.

ACKNOWLEDGMENTS

The author wishes to express his indebtedness to Dr. E. N. Transeau and Dr. G. W. Blaydes, of the Department of Botany of the Ohio State University, for their many helpful suggestions and criticisms, and to botanists in the various states who have so generously assisted in these studies.

LITERATURE CITED

1. AVERY, GEORGE S., JR. Structure and Development of the Tobacco Leaf. Am. Jr. Bot. 20:565-592. 1933.
2. BRITTON, N. L., and A. BROWN. An Illustrated Flora of the Northern States and Canada. 3 Vols., 2d ed. Chas. Scribner's Sons. 1913.
3. CLAYTON, JOHN. Flora Virginica. 2d edition. Edited by Gronovius. 1762.
4. DE CAISNE. Bulletin de la Société de France. Tome 20. 1873.
5. FASSETT, N. C. Department of Botany, University of Wisconsin. Personal correspondence. 1938.
6. GOULD, F. W. The Present status of Dane County Flora. Unpublished Master's Thesis. Library, University of Wisconsin. 1937. (Grant from Alumni Research Fund of University of Wisconsin.)
7. LINNAEUS. Species Plantarum. 1753.
8. MILLER, PH. The Gardener's Dictionary. London. 1731.
9. MÖBIUS, MARTIN. Untersuchungen über die Morphologie und Anatomie der Monokotylen-Ähnlichen Eryngien. Jahrbücher für Wissenschaftliche Botanik. 14:379-425. 1884.
10. RYDBERG, P. A. Flora of the Prairies and Plains of Central North America. New York Botanical Gardens, N. Y. 1932.
11. SHETRONE, H. C. Some Ohio Caves and Rock Shelters Bearing Evidence of Human Occupancy. Ohio Archaeological and Historical Quarterly. 37:1-34. 1928.
12. SMALL, JOHN K. Manual of the Southeastern Flora. Science Press Publishing Co. 1933.
13. STEYERMARK, JULIAN A. Field Museum of Natural History, Chicago. Personal correspondence. 1938.
14. TRANSEAU, E. N. The Prairie Peninsula. Ecology. 16:423-437. 1935.

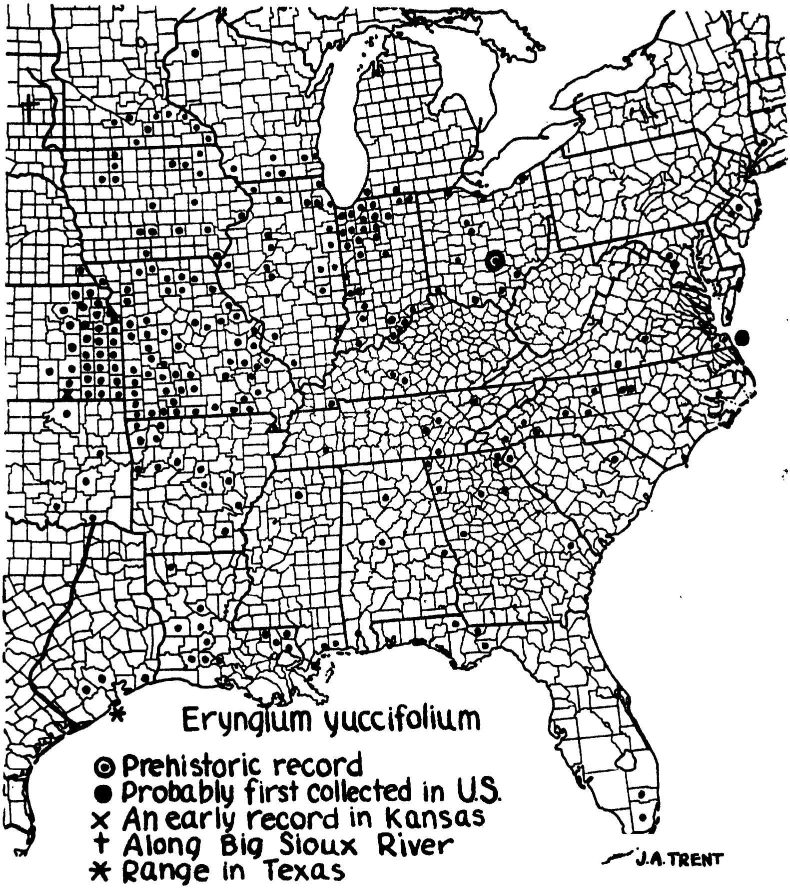


FIG. 1. Distribution map of *Eryngium yuccifolium,* by counties, in the United States

FIGURES 2 TO 15

FIG. 2. A portion of leaves of *Eryngium yuccifolium* unearthed from rock shelter in central Ohio. A prehistoric specimen. (Courtesy of H. C. Shetrone.)

FIG. 3. *Eryngium yuccifolium* growing in Jackson county, Ohio, in 1937. (Courtesy of Clyde H. Jones.)

FIG. 4. Section through the leaf of prehistoric specimen (fig. 2), showing a portion of the vascular bundle and sclerenchyma layers.

FIG. 5. Section through the leaf of a specimen collected by the author in central Ohio, Fairfield county, summer 1937.

FIG. 6. Venation in three young leaves at 30 microns; 500 microns and 1,250 microns distances from the meristematic region of the rhizome.

FIG. 7. Venation in lower 2 cm. portion of a 15 cm. leaf. (l. p.)

FIG. 8. Venation in a 2 cm. portion from near middle of a 15 cm. leaf.

FIG. 9. Venation in upper 2 cm. portion of a 15 cm. leaf.

FIG. 10. Venation in a complete 1 cm. leaf.

FIG. 11. Venation in a complete 10 cm. leaf bract.

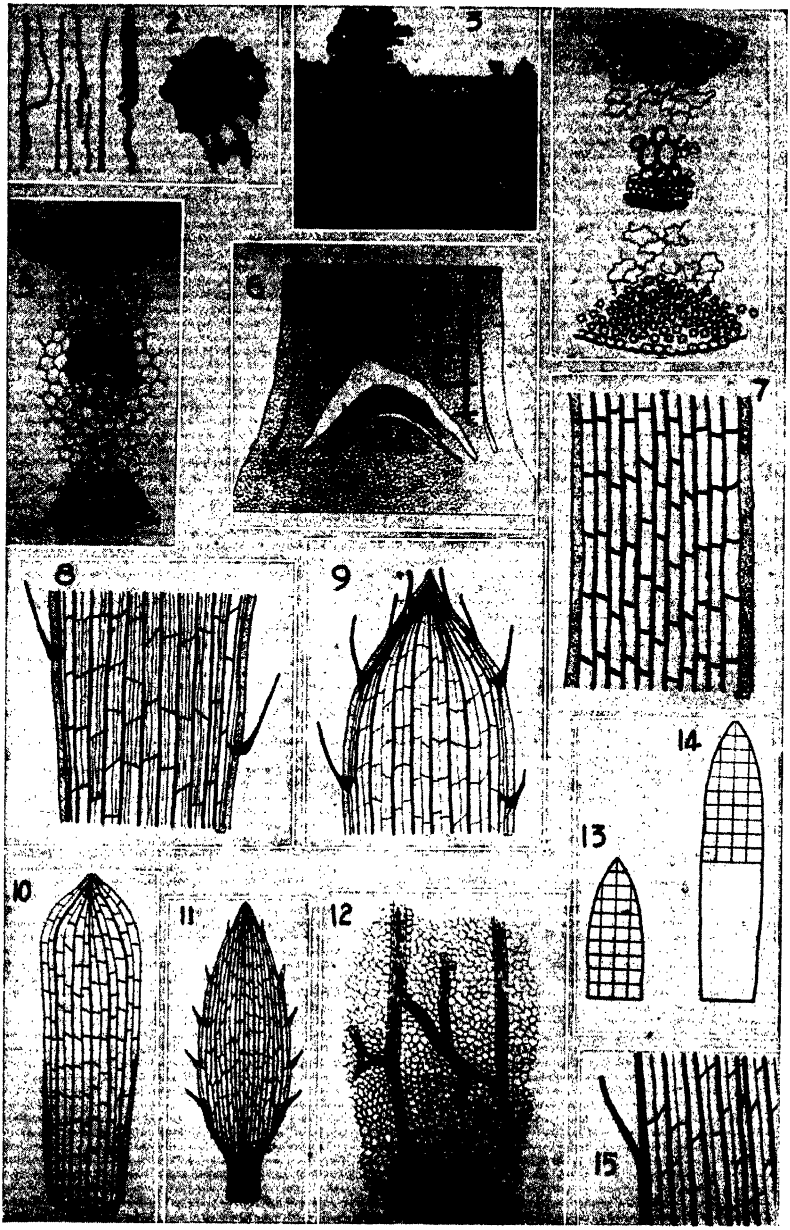
FIG. 12. Venation in detail (h. p.) from near tip of a 5 cm. leaf.

FIG. 13. A 5 cm. leaf marked in 5 mm. squares.

FIG. 14. Same leaf as in figure 13, ten days later, showing region of growth.

FIG. 15. Venation and epidermal projection from a portion of the leaf of *Yucca filamentosa*.

FIGURES 2 TO 15



Papain: A Proteolytic Vegetable Ferment

ARTHUR WILLIS BARTON, Fort Hays Kansas State College, Hays, Kan.

The enzyme, papain, is prepared from the milky juice of leaves and green fruit of the *Carica papaya,* known as papaya or pawpaw. It is a native of tropical America and cultivated in most tropical countries and in southern Florida below Palm Beach, but it does not thrive well in California.

The papain is obtained by pricking the fruits or making incisions in the bark of the tree. The hardened juice is ground, dissolved in water, filtered, and precipitated with alcohol, and dried in a vacuum. Further purification is carried out by means of aluminium hydroxide, ammonia, and dilute acetic acid. The use of papain as an enzyme is rather recent. Various substrates have been used, such as egg albumin, serum protein, milk, and more recently blood fibrin.

There seems to be considerable diversity of opinion as to the various conditions under which the ferment acts. Chesnut[1] used casein as a substrate in an alkaline medium of pH 10. In 1922 Brill and Brown[2] used a skimmed-milk powder as a substrate with samples of papain precipitated from alcohol and also sun-dried with the addition of sodium chloride, potassium chlorate, and sodium citrate. Increased activity in these salt solutions, but decreased activity was observed with lactic acid and acetic acid. Fable and Frossard[3] report the optimum activity of papain at pH 7, with decreased activity in either an acid or alkalin medium. Willstätter, Grassman and Ambros[4] report a maximum effect at a pH of 7.1, using fibrin as a substrate. On the other hand, Ringer and Grutterrink,[5] using fibrin, obtained the best results at pH 2.5 and 11, with decreases as neutrality was reached.

Investigators differ greatly in their conclusions as to optimum temperature. Ackermann[6] reports activity at 37° C., while Underrain,[7] using skimmed milk as a substrate, found an optimum temperature of 87° C. in an acid medium. In their summary of the properties of papain Waksmann and Davidson[8] give the optimum temperature as about 80° C. and the optimum pH as 5.

EXPERIMENTAL WORK

Owing to the variety of substrates used by various experimenters, it was thought best to experiment with various substances and methods.

The Roberts' meta-casein reaction.[9] A definite quantity of milk is diluted with an equal volume of distilled water, to which is added a given volume of enzyme, of known strength, both having been brought to a given temperature, say 40° C., and allowed to digest for different periods of time. A sample is

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Chesnut, J. Assoc. Official Agr. Chem., 3:387-97, 1920.
2. Brill, H. H., and Brown, R. E. Philippine J. Science, 20:185-198, 1922.
3. Fable and Frossard. Compt. rend. Soc. Biol., 92:59-60, 1925.
4. Willstätter and Grassman. Z. Physical Chem., 152:160-168, 1936.
5. Ringer and Grutterrink. Z. Physical Chem., 156:275-321, 1927.
6. Ackermann. Colloqium, p. 601-51, 1930.
7. Underrain. Milchwertschaft. Forsch., 15:433-47, 1933.
8. Waksmann and Davidson. Enzymes, Chapt. XI, p. 224 et seq.
9. Sir William Roberts, M. D. Proc. Roy. Soc., 32:145, 1881.

taken from this and brought to boiling as quickly as possible, the digestion being recognized by the onset of coagulation. Another method used is the Fuld-Gross method,[10 11] which consists of dissolving 800 mg. of anhydrous casein in 50 c.c. of distilled water and 5 c.c. of 0.1 N sodium hydroxide. This solution is made up to 400 c.c., and 6 c.c. of this solution (representing 12 mg. casein) are taken for each test. To this sample is added a water solution of the ferment of known concentration to bring the volume to 10 c.c.; both sample and water having previously been raised to a given temperature in the water bath. The test solution is allowed to digest for one hour, when it is treated with 3 drops of diluted acetic acid (1 vol. glacial acetic acid with 50 c.c. alcohol and 49 c.c. of distilled water). Digestion is recognized by the absence of cloudiness or precipitation on addition of the acid mixture.

Mett's tubes.[12] In this method small glass tubing 2 mm. in diameter is filled with raw egg albumin and placed in boiling water until coagulated, when it is cut into 2 cm. lengths. These pieces are put into the ferment solution and left for the desired time. Digestion is indicated by distance to which the enzyme has dissolved the substrate at both ends of the tubing.

In the preliminary work here reported to determine the optimum temperature, it was found that the activity increased with rising temperature from 40° C. to 80° C. Destruction of the enzyme occurs at about 87° C. The activity at body temperature was practically nil, indicating that papain is useless in the human body. Difficulty was experienced in the selection of a suitable substrate, owing to uncertainty in the determination of an end-point. The Mett's tube method seemed to offer too little contact of enzyme and substrate, even after 24 hours. The Fuld-Gross method seemed to be the most satisfactory when milk is used as a substrate. Probably the best substrate for digestive experiments is blood fibrin, which, unfortunately, was not available for these experiments. Various pH media were used from 1.27 to approximately 8.

CONCLUSIONS

From my experiments so far conducted it is evident that: (1) Papain does not digest protein in any acid medium. (2) There is no action at body temperature, but activity increases up to 80° C. (3) The maximum temperature is somewhat less than 87° C. (4) The medium must be alkaline, no digestion taking place at the neutral point.

Further experimentation to determine the most suitable substrate, the most favorable pH, and optimum temperature is in progress. The papain used in these experiments was furnished by Tendra Kitchens, Inc., Cincinnati, Ohio.

---

10. Gross. Arch. Esp. Path. & Pharm., 58:57, 1906.
11. Long & Barton. Jour. Amer. Chem. Soc., Vol. 36; October, 1914.
12. Mett, Arch. f. Anat. u. Physiol., Verda 1894, p. 68.

The Economy of Water Softening

H. W. BRUBAKER, Kansas State College, Manhattan, Kan.

That the general public recognizes the need for and the value of an adequate supply of pure water for every community is shown by the fact that there are now in the United States 10,790 public water supplies serving 77,523,414 people, which is 63.1 percent of the total population of the 48 states and the District of Columbia. The other 36.9 percent, mostly in rural sections, are of necessity compelled to take care of their own water problems individually.

The first concern of any community with reference to its water is to secure a sufficiently large and continuous supply which is fit for domestic purposes. The next consideration has always been and always will be the purity of the water.

As a consequence of this consideration many municipalities give the water a filtration treatment or, in many cases, a chemical treatment combined with filtration, to purify it. By purification is meant removing or destroying suspended impurities, including living organisms, especially pathogenic bacteria.

There are several types of water sources from which communities draw their supplies: ground waters, either from shallow or deep wells; surface waters which may be from flowing streams, lakes, natural ponds or impounded waters. From the standpoint of purity as we have defined it, the deep well waters are in general the best and are often used with little or no attempt at purification. However, this type of water is usually insufficient in amount in any locality to take care of a very large population, and is therefore limited to the use of smaller communities fortunate enough to have this type of supply at hand.

Large rivers and lakes, either natural or artificial, are depended upon generally by the larger centers of population. These waters invariably need chemical treatment combined with filtration to make them safe for domestic use.

The purification of water for domestic purposes is not primarily an economic question, as it is usually considered necessary by any community to have a pure water, whatever the cost. It is not the purpose of this paper to argue for pure water or to discuss the question, but to take it for granted.

Having briefly introduced the subject of public water supplies, we will take up the particular question I have in mind.

There are many ways of approaching the "more abundant life," none of them political, nor by the manipulation of "watered stock," but one of them by means of softened water which at the same time softens somewhat the way of life for many housewives in their daily tasks and makes less hard the burden of the Saturday night bath for the whole family.

If one has been compelled to contend in his bath with the sticky scum which forms as a result of the action of soap with an extremely hard water and then suddenly is permitted the luxury of a bath in a pure soft water, he becomes at once an enthusiast for soft water.

Trans. Kansas Acad. Science, Vol. 41, 1938.

In 1906 there were only two municipal water softening plants in North America. Prior to this a number of plants had been built in England, where the practice first started. One of these plants was built in Winnipeg, Canada, in 1903. In 1905 the city of Columbus, Ohio, built the other, which was at that time the largest complete water softening plant in the world. This plant now has a capacity of about 60,000,000 gallons per day. Two plants in St. Louis, Mo., using partial softening with lime alone, are larger. One, the Chain of Rocks plant, has a capacity of 160,000,000 gallons per day; the other, the Howard Bend plant, has a capacity of 80,000,000 gallons.

Since the construction and successful operation of these early plants water softening has increased very rapidly, until at the present time there are more than 250 municipally owned water softening plants in the United States using the lime-soda process and many times that number of industrially owned plants. Railroads alone own and operate for their own use more than 900 small plants, softening about 150,000,000 gallons of water each day. In addition to these there are approximately 100 municipally owned plants using the zeolite process of softening.

The territory of the Missouri Valley section of the American Water Works Association, which includes the state of Kansas, is known as a hard-water region. This section has therefore a special need for water softening.

There are in Kansas 24 municipalities with water-softening plants. The first was built at Lawrence in 1920, the next at Erie in 1921, and the next two at Topeka and Manhattan in 1922. Since then have followed (alphabetically): Athens, Baxter Springs, Beloit, Clay Center, Clyde, Coffeyville, Council Grove, El Dorado, Emporia, Fort Leavenworth, Hanover, Hoisington, Independence, Iola, Lincoln Center, Linn, Neodesha, Pittsburg, Russell and Washington.

My home being in Manhattan, I am primarily interested in the Manhattan plant. The first municipal water supply for Manhattan was established in 1887. The water was taken from the bed of the old Blue river through a pipe line of porous tile and pumped to the city without treatment of any kind. Then in the eighteen nineties, eight six-inch points were driven in the sand on the bank of the river.

In 1908, when the Blue river left the old channel and established its new channel three miles to the east, these wells began to fail. In 1912 two new wells were dug in the old channel of the river. These were not a success, as the sand was too fine to permit the flow of enough water. In 1914 the first of the present large wells was dug in a section of the channel where the gravel was coarser. Since that time a number of new wells have been dug, each one lasting from six to eight years.

At present we are pumping from four wells, one of these being one of the original wells dug in 1914. The water from these wells is very hard, having a total hardness of over 400 parts per million, most of which is bicarbonate hardness. This water also has a high iron content, an average of about 10-11 ppm. Needless to say, the water was very unsatisfactory for either domestic use or for industrial purposes.

About 1919 agitation was begun to interest the people of the city in a plant for softening and filtering the water. In 1920 a proposal was submitted to the voters to issue bonds for the building of such a plant.

This proposal failed to carry by a vote of 3 to 1. Then there was begun

a planned campaign of education and persuasion. Among other things a small-sized model of a softening plant was placed on a vacant lot to demonstrate what softening would accomplish. Then a number of people were persuaded to pump out the rain water from their cisterns and to replace it with water from the city pipes and to allow us to soften it by the proper lime treatment. Eventually there were many of these cisterns filled with softened city water scattered over the city. Each of these became a convincing argument in its neighborhood for softened water.

In 1922, two years after the first proposal was turned down by the voters of the city, a similar proposal was placed before them and was adopted by a vote of nearly 3 to 1, reversing the verdict of the first election.

The softening plant, costing approximately $70,000, was built and began operating in the spring of 1923. This plant has operated successfully with the removal of all but a trace of the iron and a reduction of hardness from 450 ppm. to 125-150 ppm. by means of lime as the only softening agent.

The cost of the process has been about 2.8 cents for 1,000 gallons of water, not including the pumping, which is a necessary part of delivering water to the people whether it is softened or not. The total cost for one year of softening 1,500,000 gallons of water per day has been about $10,000. We have made calculations based upon reliable data gathered in other comparable communities that the annual saving of soap alone exceeds this amount.

After fifteen years it became necessary to enlarge the Manhattan plant and improve it in certain respects. This has cost the city about $30,000 and has just been completed. Since remodeling the plant the hardness of the water has been further reduced from 125 to approximately 75 parts per million.

During the remodeling of this plant it was necessary to deliver raw, untreated water through the mains to the people of Manhattan for a period of about three weeks. This was a trying time for the people of Manhattan, and when the period had passed and softened water was again sent into the mains, the whole community heaved a great sigh of relief. If a canvass of the city were made today I doubt whether one person could be found who would willingly return to the use of the unsoftened water, regardless of cost.

However, I wish to say that the softening of the city water in Manhattan has been a money-saving proposition as well as a joy and satisfaction to every resident of the city.

I will enumerate some of the savings. These can be realized in any community, large or small, whose water is so hard as to be unsatisfactory for laundry purposes. As a conservative estimate, $12,000 per year has been saved on the cost of soap. This amount is sufficient to cover the cost of the softening reagents. An additional saving of several thousand dollars is made on scouring powders previously necessary for the removal of iron stains from bath tubs, sinks, stools and lavatories.

Another saving, estimated at $3,000 to $4,000 each year, is due to the fact that water-heating coils now last many times as long as formerly because of the greatly reduced lime incrustation.

A very large saving, which would be difficult to estimate, is in the wear and tear of clothes and all fabrics caused by the stiffening effect of lime soap produced by hard water. In addition, there is the long-time saving from the reduction of incrustation of all water pipes, especially those carrying hot water

and those involved in the production of steam in laundry, dry cleaning and industrial plants of any sort.

Kansas towns and cities have a special need for water softening, as both the ground waters and surface waters of the state are very hard, having an average hardness of approximately 330 parts per million. In most cases it would be practical to reduce the hardness to less than 100 ppm. This reduction would give a satisfactory all-purpose water for any community.

There are two general methods of water softening: one is by means of lime or lime and soda, and the other is by means of zeolite. Both of these methods have been found practical in municipal water softening. Many plants of both types are in existence. In general the lime-soda process is more appropriate for larger communities. The original cost of construction is more, but the cost of operation is somewhat less. The automatically controlled zeolite process has recently been established in a number of smaller towns and has proved very successful, being reasonably economical both in its original cost and its operation.

There are a number of towns in Kansas where the water has a dangerous amount of fluorine in it. This substance causes a disease of the teeth commonly known as mottled enamel of the teeth. In severe cases it may cause complete destruction of the teeth of children. The most effective method so far discovered for reducing fluorides in the water below the danger point, which is about 1 part per million, is to use an excess of lime in the lime process of softening. Magnesium in the water precipitating as the hydroxide, drags down the fluoride, removing it in the sludge. In some of these waters there is enough magnesium to bring about a sufficient removal of fluorides; in others it would be necessary to add a certain amount of magnesium salt before softening to accomplish the desired result.

This paper has not been intended as a discussion of water softening nor does it pretend to present anything new. It is a plea to all Kansas communities using hard water to take advantage of the now well-established methods of curing this evil so that each community may be a more desirable place in which to live.

The Electrodeposition of Tin From Solutions of Its Complex Salts

ROBERT H. HESS and ROBERT TAFT, University of Kansas

This study has been made to determine the effect of complex compound formation on the properties of tin deposited electrolytically from a number of tin-plating baths. The best deposits, from a plater's standpoint, are those which are smooth, coherent and adherent, and which can be built up to any desired thickness.

The detection of complex compound formation may be accomplished in several ways, (1) such as measurement of conductance, marked color change, and by noting whether the metal ion remains in solution in the presence of a reagent which would ordinarily cause it to precipitate. The last method was used in this study. In addition to this, each bath was actually tried out as a plating bath, in order to determine the best deposit as defined above.

We began our study by preparing two molar solutions of stannous chloride and stannic chloride. Two ml. of each of these stock solutions were added to each of two series of test tubes, and various organic compounds which might form complex salts were then added to the different tubes in each series and mixed. Sufficient sodium carbonate solution was then added to make the solution distinctly alkaline. This procedure would ordinarily cause the simple metal ion to precipitate. If precipitation did not take place it was assumed that a complex salt had been formed. The following substances were tried in this manner: formic acid, acetic acid, lactic acid, gallic acid, oxalic acid, Eastman's "Pure" glycollic acid, Eastman's "Practical" glycollic acid, ammonium citrate, ammonium acetate, sodium tartrate, sodium thiocyanate, amyl acetate, glycerol, triethanol amine, disodium phosphate and borax.

The premilinary work indicated that sodium tartrate, ammonium citrate and oxalic acid formed complex salts with the stannic ion, but only ammonium citrate formed a complex salt with the stannous ion. Considerable time was spent trying to develop other plating baths with the stannous ion which, of course, would require only one half the current to plate the same mass of material. The proportions of the addition agents were varied over a wide range. The same baths were made decidedly acid and then strongly alkaline (*i.e.*, until the precipitate which formed redissolved) with sodium hydroxide. From these numerous trials, it was concluded that stannous ion forms a complex salt only with the citrate ion.

These solutions, namely stannic tartrate, citrate, and oxalate, as well as stannous citrate, were studied in detail as plating baths. Observations were made as to the effect of changing the temperature, current density, concentration of the metal salt and the molar ratio existing between the tin salt and the complex forming agent. The current efficiencies of each bath tried were also determined.

These observations were made by placing ten 100 c. c. beakers, containing the plating baths, in series with a copper coulometer at each end of the circuit. Two potential dividers were used to regulate the current. The cathodes were

Trans. Kansas Acad. Science, Vol. 41, 1938.

cut from sheet copper and made 2 cm. × 2 cm.; the current densities were calculated, using one side of the cathode. It was necessary to use platinum anodes in the stannic plating baths because precipitates were formed when tin anodes were employed. Such precipitates were carried to the cathode, and produced rough, nonadherent deposits. Tin anodes were used with the stannous citrate plating bath.

In order to determine the optimum conditions for each plating bath, molar ratios of complex forming agent to tin chloride varying from 0.25 to 4 were used as were, temperatures from 0° C. to 75° C., current densities from 0.1 to 10 amp/dm^2 and concentrations of the metal salt ranging from 0.05 to 0.5 molar, one variable at a time only being changed. The conditions under which the plating baths from each complex forming agent yield the best deposit are given in Tables I and II.

TABLE I.—Composition of plating baths and conditions for best deposits

TIN SALT.	Concentration of tin salt.	Complex forming agent.	Concentration of complex agent.	Current density amp./dm^2.	Temp.	Current efficiency.
Stannic chloride...	0.25M	Sodium tartrate...	0.50M	0.5	30°C	91%
Stannic chloride...	0.25	Ammonium citrate,	0.25	5.0	40°C	94%
Stannic chloride...	0.25	Oxalic acid......	0.125	5.0	30°C	99%
Stannous chloride,	0.25	Ammonium citrate,	0.63	0.5	45°C	100%

TABLE II.—Decomposition potentials

SYSTEM Anode/Electrolyte*/Cathode.	For tin deposition.	For hydrogen evolution.
Sn/Stannic chloride,/Cu... Sodium tartrate.	0.07 volts	0.64 volts
Pt/Stannic chloride,/Cu... Ammonium citrate.	1.6 volts	2.1 volts
Pt/Stannic chloride,/Cu... oxalic acid.	1.7 volts	2.1 volts
Sn/Stannous chloride,/Cu... Ammonium citrate.	0.0 volts	0.33 volts

* Of concentrations shown in Table I. The decomposition voltages were determined by the familiar method of LeBlanc. (2)

The deposits obtained from the stannic plating baths were adherent and smooth, but were very thin and would serve only as a protective coating in the absence of abrasion. A slight scratch would expose the underlying metal. When attempts were made to obtain thick deposits, dark, spongy, nonadherent masses were obtained. Such baths would obviously be of little value from a commercial standpoint.

The stannous citrate bath, however, gave thick plates which were fairly smooth. It was possible to use tin anodes in this bath, which is a desirable feature, as anode corrosion can be used to maintain the metal ion concentration.

Deposits were obtained with this plating bath which had a calculated thickness of over 0.5 mm. When a thicker plate was applied, the surface became somewhat rought, but was very firm and adherent.

Very few good deposits of tin have been reported. Mathers and Cockrum (3) and Mathers and Bell (4) have reported good deposits, but the baths were not stable. Baths which had been recommended by Blum and Hogaboom (5) and by W. Fraine (6), were prepared, as well as the two mentioned above, and compared with the stannous citrate plating bath discovered in this study. The deposits obtained from the stannous citrate bath excelled the others by far.

Further study should be made on the stannous citrate bath to see if it is possible to find addition agents, or organic colloids, which will give still smoother deposits, as this bath appears to offer excellent possibilities from the plater's standpoint.

LITERATURE CITED

1. THOMAS. Complex Salts. Blackie and Son, London, (1924).
2. Zeit, Phys. Chem., *8*, 299 (1891).
3. MATHERS and COCKRUM. Trans. Am. Electrochemical Soc., *29*, 411 (1916).
4. MATHERS and BELL. Trans. Am. Electrochemical Soc., *38*, 135 (1920).
5. BLUM and HOGABOOM. Principles of Electroplating and Electroforming, page 336, McGraw-Hill Book Co., New York, (1930).
6. Monthly Rev. Am. Electroplaters Soc., vol. 13, No. 8, Aug. (1926).

Partial Molal Volumes of the Binary Systems: Water—Cellosolve and Water—Carbitol

AGNES NIBARGER and LLOYD McKINLEY, Department of Chemistry,
University of Wichita

ABSTRACT

The partial specific volumes of the components in the binary systems: Water—Cellosolve and Water—Carbitol at 25° C. were ascertained on a series of solutions ranging from one component to the other in intervals of one percent by weight.

For each system an equation was obtained to express the specific volume of the solution as a function of the weight fraction.

Accordingly, "the Method of Intercepts" employed became analytical rather than the graphical or "straight edge" method.

Graphs were presented to show: (1) Variation of specific volume with concentration. The maximum density for an aqueous solution of cellosolve is that of a 25 percent by weight cellosolve mixture, whereas for the carbitol—water system the maximum density is at 68 percent carbitol. (2) Departure of v, the partial molal volume, from v°, the molal volume in the pure state, as concentration is varied. (3) The magnitude of volume changes which would be experienced by each component in the preparation of a series of 1,000 c.c. solutions of varying concentrations.

The total change in volume accompanying the preparation of each of these solutions is shown to be the algebraic sum of two effects and is found to be most pronounced for a 52 percent by weight solution of cellosolve and for a 57 percent by weight solution of carbitol.

Refractive indices were obtained for the solutions prepared. An attempt is made to show correlations between these data and those depicted in (3).

Trans. Kansas Acad. Science, Vol. 41, 1938.

Controlling the Color of Iron Clays

WILLIAM K. ZINSZER, University of Alabama, Tuscaloosa, Ala.

INTRODUCTION

Posnjak and Merwin; Kurnakow and Rode; and Thiessen and Koppen[1] made studies of the hydroxides of iron. Carli, Rohland and MacCarthy[2] investigated the adsorption characteristics of ferric hydroxide sols. Orton[3] collected the existing knowledge of his time on the coloration of clays by iron. Greig; Posnjak; Merwin and Sosman[4] investigated the dissociation of ferric oxide under various conditions. Kleffner and Kohlmeyer[5] investigated the reaction which takes place between silica and iron oxide. In this experiment the writer has undertaken the problem of bleaching out the iron colors by the addition of calcium oxide in the form of calcium carbonate, taking into consideration the ignition losses.

OCCURRENCE

Iron, as it occurs in various clays, plays a large part in coloring the clay This iron is in the form of complex silicates as hydrous ferric-silicate, ferric-silicates or as oxides, sulfides or carbonates. In the mineral forms it occurs as hematite (Fe_2O_3), magnetite (Fe_3O_4) or ferrous oxide (FeO). Upon firing, these oxides of iron change to characteristic colors, depending upon the compound in which they are found and also the quantity or percentage composition.

PROCEDURE

Samples of A1 English China clay were used throughout the experiment. The samples, consisting of 100 grams of clay, were placed in a mixer with 100 c. c. of water, and the clay was thoroughly blunged (mixing of clay and water). Ferric chloride solution was then added with a burette. The solution was made approximately two molar and standardized. 6.644 mls. of solution were found to contain the equivalent of one gram of ferric oxide. This solution was added to the clay samples in varying amounts from one to ten grams in each series. Ammonia was then added until the mixture was neutral. This precipitated the iron in the clay as iron hydroxide. Merk's U. S. P. calcium carbonate was added in varying amounts from one half to twenty-four grams, ignition losses for the calcium carbonate being determined. ($CaCO_3 + \text{heat} \rightarrow CaO + CO_2 \uparrow$.)

This mixture was then blunged thoroughly, placed in viscose casing and dialyzed in running water for two days, thus completely removing the ammonium chloride which was formed in the reaction.

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Hydrated Ferric Oxides: Am. Jour Sci., 47, 311-348, (1919).
2. Z. Physik. Chem., 12, 263-272, (1913).
3. Role of Iron in Clay Burning: Trans. Am. Cer. Soc., pp. 377-430, (1903).
4. Equilibrium Relations of Fe_3O_4 and Fe_2O_3 and Oxygen: Am. Jour. Sci., (5) 30, 239-316, (1935).
5. Influence of Silica on Dissociation of Iron Oxide: Metall. u. Erz., 29, (10) 189-194, (1932).

The clay mixture was then filtered through a Buchner funnel and placed in a dryer at 125° C. until thoroughly dry. Upon losing all of their shrinkage water, the clays were ground to powder in a procelain mortar and made into bars. Each series contained eighteen samples, and from each sample six bars were made up. Each bar of any particular sample was fired at a different temperature, necessitating five different firings for each sample.

For firing an electrically controlled glow bar muffle furnace was used, the five firings running as follows: 1,750° F., 1,900° F., 2,100° F., 2,250° F., and 2,300° F. In each firing the temperature was raised gradually at the rate of 250 degrees per hour, thus making it possible for an oxidizing atmosphere to occur in the kiln. After all the bars had been fired, approximately five hundred in all, the color of the bars was compared.

COLOR MEASURING

The measuring of the color was done with a standard Lovibond tintometer in conjunction with an especially constructed illuminator for matching the color of all the samples of the fired clays. The design of the illuminator followed closely the one made by the Lovibond Company, except that 60-watt tungsten filament bulbs were used, and Corning "Day-lite" glasses were substituted for blue glass screens. The interior of the illuminator was whitewashed with basic magnesium carbonate, to which a small amount of glue was added to serve as a bond. All samples were placed so they were parallel with the aperture of the instrument and they were illuminated by lamps placed at angles of 45° to the specimen. A block of white magnesia was used as a reference for white light.

The principle[6] of the instrument is that the reflected light from the sample whose color is being measured covers one half of a divided field, while the other half is illuminated by the light reflected from white magnesia. The instrument is so constructed that standard glasses can be interposed between the standard light source and the corresponding half of the divided field. When proper proportions of red, blue and yellow light are thus interposed a close color match can be obtained, and the proportions of these standard colors used can be determined by direct reading. There are three slides for each color: one having units of ten; a second being graduated from one to nine; and, a third being graduated from one tenth to nine tenths. Consequently, the instrument has a wide range. There are also two neutral slides which are used for dimming the intensity of very bright colors.

RESULTS

After all the samples were measured, a chart was made plotting the amount of calcium carbonate as one ordinate and the amount of iron as the other. Each sample was marked on the chart with the amount of red, yellow and blue required to measure the sample.

Red clays were remarkable for the regularity of their iron content; ordinarily between four and seven percent content burns as fine a red as seven or eight percent content. The coloring propensities of ferric oxide are both opposed and augmented by the presence of fluxes. At relatively low temperatures,

---

6. A Simple Method of Color Matching: Kan. Acad. Sci. Trans., 38:243. 1935.

where the amount of fused material is small, the color is intensified by the suspension of the iron particles. As the temperature is increased and more fused material is formed, the iron is taken into solution and its coloring effect decreased. The addition of feldspar to some of the samples in all cases turned out good reds and buffs depending on the amount of iron present. Samples fired at 1750° F. and 1900° F. remained an even red and salmon color; while those fired at 2100° F. to 2300° F. either fired dark brown, salmon or buff. Even grays were also formed at the latter temperatures. Clays with a high content of lime were all gray and very dense with high shrinkage.

The conclusion drawn from this research in regard to the bleaching power of calcium oxide upon the iron in the clay, resulting upon firing, was that a maximum bleaching took place with the addition of three to five percent of calcium oxide with varied percentages of iron.

Acknowledgments are due Dr. Thos. N. McVay, professor of ceramics and mineralogy, under whom this research was performed, for many kindly criticisms and suggestions.

Parasite Emergence Holes as an Aid in Determining Hessian Fly Infestation in Mature Wheat Plants[1]

ELMER T. JONES, U. S. D. A., Manhattan, Kan.

As F. M. Webster and others have long since pointed out, distinctive purple coloration, shortened central leaf, general deterioration of infested tillers, and other noticeable external plant characteristics denoting fall infestation, afford a means for detecting infested wheat plants in the rosette stage. These characters are of little use in determining Hessian fly infestation on mature plants, but the writer has found that the presence of parasite emergence holes is a very helpful means of readily recognizing Hessian fly infestations in such plants. In making fly-resistant selections the writer has for several years obviated the necessity of making laborious dissections by using the presence of parasite emergence holes as a basis for discarding susceptible plants.

During the past season the observation of the emergence holes of *Merisus destructor* (Say) and *Eupelmus allynii* (French) in the sheaths of infested plants has permitted rapid field selection of resistant material from a large series of F_2 hybrids. Upon dissection, the plants selected on this basis were found to be fly free. Typical samples of infested stems are shown in figure 1.

Although it is possible that the presence of parasite emergence holes has been used by other entomologists as an indication of infestation in mature wheat plants, no reference to the use of this method has been found in the literature.

In order to determine the reliability of this method of selection, records of infestation in 38 eight-foot distributed rows of the parental checks of the above hybrid series, as determined first by observation of parasite emergence holes and then by actual dissection of the plants, were compared. For this purpose the ripened plants were pulled from the test plots, shipped to the laboratory, and examined within 6 days thereafter. Differences caused by excessive handling, with resulting loss of stems between counts and irregular emergence of parasites, were noted in the case of a number of rows, but, in general, correlation between the infestations in the respective rows, as indicated by parasite emergence and the actual infestation as shown by dissection, was surprisingly close. A correlation coefficient of $.90 \pm .03$ was obtained for plant infestations and $.81 \pm .03$ for culm infestations. Under the conditions of moderate parasitization which prevailed in this test, the plants offered a slightly more reliable unit of infestation than the culms. In years of Hessian fly abundance, with the heavy parasitization generally prevalent in puparia of the second spring brood, it is suggested that entomologists and plant breeders might find this a useful and time-saving method for determining the amounts of fly infestation present in their test plantings and field samples without material loss in accuracy.

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Bureau of Entomology and Plant Quarantine No. 4532.

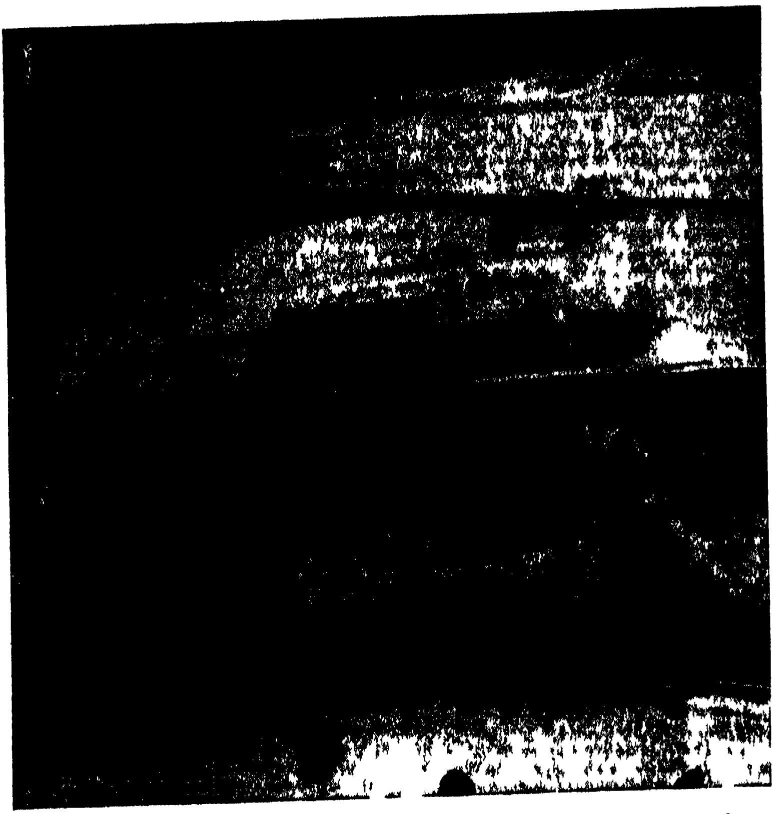


FIG 1—Emergence holes of Hessian fly parasites in leaf sheaths of wheat

A Preliminary Report on the Insects Attacking Bindweed, With Special Reference to Kansas[1]

ROGER C. SMITH,[2] Kansas Agricultural Experiment Station, Manhattan, Kan.

The seriousness of bindweed as a farm-weed pest in the Central West is now generally understood, and many persons have suggested the possibility of biological control of it. This method, which means the utilization of introduced insect or plant-disease enemies of the plant, has achieved remarkable success in Australia in the eradication of prickly pear. The chemical control of bindweed by spraying with sodium chlorate, 1 pound to 1 gallon of water, or placing a small amount of the dry chemical around the base of the plant, is widely practiced with fairly good success. The chemical method is expensive, and repeated sprayings which are necessary usually cause injury to the soil. Crops may not grow satisfactorily on soil sprayed with sodium chlorate for three or more years, and it is generally left strongly alkaline for an indefinite period. Smothering out the weed with alfalfa or sweet clover is preferred by some.

The question has arisen as to why bindweed has increased in recent years, particularly as to whether the natural enemies of the plant have been reduced.

A brief study of the insect enemies of bindweed during the summers of 1935, 1936 and 1937 was made in connection with the alfalfa-insect project for information on the possibilities of biological control of this serious weed, and to ascertain whether bindweed was an important food plant of any farm or garden pests.

Bindweed belongs to the morning-glory family, Convolvulaceae. Two species of the bindweeds in Kansas are important—the hedge bindweed, *Convolvulus americanus,* and the field bindweed, *Convolvulus arvensis* (fig. 3.) The latter species, characterized by its smaller leaves and white flowers, is the more serious agricultural pest. The hedge bindweed occurs predominantly in the eastern part of the state. It has larger leaves and coarser vines than the field bindweed. The flowers are large and the color is predominantly pink or rose-tinted. The large majority of the collections and rearings during these studies were from the field bindweed, which was by far the more numerous of the two species in this region during 1935, 1936 and 1937.

Both species of bindweed occur in central Kansas in greatest amount on waste and uncultivated land, such as roadsides, ditches, railroad rights-of-way, uncultivated fields, fence rows, and even grassland, such as lawns. However, spots are frequent in cultivated fields where there is such a luxuriant growth of this weed as to make the growing of crops impossible. Bindweed spreads rapidly, both from root buds and seed. An aspect of the problem is to effect control of this weed in the uncultivated, out-of-the-way places, because plants in such places produce seed which spreads the weed to cultivated land.

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Contribution No. 461 from the Department of Entomology.

2. This is a report of certain results obtained on Experiment Station Project 115. The writer was assisted by J. O. Rowell, R. C. Brown, Jr., and Wm. Luther Hoyle.

REVIEW OF LITERATURE

Gray, in his Manual of Botany, lists Europe and Eurasia as being the original home of the two species of bindweed. There is a belief in Kansas that the weed was introduced from Russia by immigrants, or with Russian wheat.

Paddock (1912) pointed out that the beet webworm, which is a common imported insect occasionally occurring in numbers in Kansas, has been found feeding on bindweed in Europe, in addition to several other plants. He does not report it feeding on this plant in the United States.

According to Fuller (1914), the bindweed in Pietermaritzburg and its environs has been adopted by a longicorn beetle, *Nupserha apicalis,* as a host. The native plant on which this beetle forms galls has not been determined, but it probably is an indigenous *Convolvulus* or *Ipomoea.* The galls, which are always concolorous with the stem and become hard and woody in the winter, are elongate, hollow swellings, tapering at either end into the stem. They are two or three inches long and may be either straight or spiral, and are found more frequently on climbing vines than on those trailing over the ground. The adult beetles emerge from the galls in the spring and oviposit on the young bindweed during November. The larvae are full fed in April and May, when they construct a strong and hard cocoon in the gall cavity in which they hibernate, pupating in the spring.

Tucker (1917) found specimens of a caterpillar on rose leaves in Baton Rouge, La., in October, 1913, and September, 1914, which were determined as the bindweed prominent, *Schizura ipomeae,* Ddy. The larvae of this moth is responsible for slight injury to pecan foliage.

Newcomer (1916) stated that the dock false-worm, the larvae of the sawfly *Taxonus* (*Ametastegia*) *glabratus* Fall. attacks bindweed among other weeds. This insect is found all over Europe and in Canada. It feeds upon plants belonging to the buckwheat family, including the numerous docks, sorrels (*Rumex*), the knotweeds, bindweeds, and wild buckwheat (*Polygonum*) and others. There are four generations of *Taxonus glabratus* annually, each occupying about a month, except the fourth, the larvae of which hibernate and complete their development the following spring. Only the larvae of this last generation are known to bore into apples. This sawfly is parasitized by the Ichneumonids, *Epiurus pterophorae,* Ashm., *Spilocryptus* sp., *Aenoplex* sp., *Bathyrix* sp., *Trichogramma minutum,* Ril., which attacks the eggs, and the Braconid, *Rhysipolis* sp. It is preyed upon by two Chrysopid larvae and probably by coccinellid larvae.

CHEMICAL AND CULTURAL METHODS OF BINDWEED CONTROL

Control of this farm weed pest by chemical means is well summarized by Latshaw and Zahnley (1927), who developed the sodium chlorate treatment, now widely used in Kansas and the central west. The use of this chemical and the fallow-smother-crop method are well discussed by Call and Getty (1923) and Zahnley and Pickett (1934).

The success of the biological eradication of prickly pear from approximately 25,000,000 acres of good land in Australia by introduced insect and mite enemies (Dodd, 1936) has given the subject of biological control of weeds new importance. The project of eradicating biologically the Noogoora bur, which is a close relative of the cocklebur of the United States (Kelly, 1931), has been

undertaken in Australia and shows promise of good results. The various aspects of the question of the biological control of weeds, with the precautions to be taken in insect introductions for the purpose, are well summarized by Tillyard (1929).

METHODS OF PROCEDURE IN THIS STUDY

In this study, two methods of obtaining the insect enemies of bindweed were used—general field collecting and shoebox rearings. Bindweed plants, or portions of plants, were collected in the field and placed in pasteboard shoeboxes. A small glass vial, with the open end inside, was placed in the end of each box. In the course of weeks, various insects emerged from the bindweed, and being attracted by the light, entered the vial from each box. This method of sampling resulted in the large numbers of the smaller forms from bindweed plants.

FIELD OBSERVATIONS AND COLLECTIONS OF BINDWEED INSECTS

The following insects were observed feeding upon the leaves of bindweed or were collected in the shoebox rearings:

Bedellia somnulentella (Zell)., the morning-glory leafminer (figs. 1, 5 and 8.) Family, Lyonetiidae. Order, Lepidoptera.

This lyonetid moth was the most abundant insect attacking bindweed during the three summers. The moth is a micro-lepidopteran, dull gray with minute dark spots or pepper-and-salt colored, 4-5 mm. in length. The eggs are deposited on the bindweed leaves. They hatch in three or four days to black-headed leaf-mining larvae, which may be green or purplish with yellow spots. The larvae are quite active, moving quickly backward or forward. At first the mine is serpentine, with a middle line of frass in the form of coils. Later the mine is enlarged to form a blotch mine, and finally the larvae feed externally where they web up the surface of the leaf and finally pupate in the web. The old pupal skin remains attached to the web (fig. 8).

This leafminer is common at Manhattan from early June to late August. It has at least two broods in Kansas each year. As a result of its work, the leaves develop brown dried areas or may be wholly destroyed.

The effectiveness of this insect is largely nullified by an *Ichneumonid* parasite, *Apanteles bedelliae* Vier. (figs. 9 and 10). The white cocoons during the summer are common on the under sides of bindweed leaves. Not infrequently two cocoons may occur on a leaf. The species was originally described from a host of this genus, and Leonard (1926) lists it as a parasite of this host species with several others.

Spilochalcis albifrons Walsh is a chalcid parasite, also reared in large numbers, especially in August and September, possibly from the morning-glory leafminer, also. The laboratory record states the host was a "blotch leafminer."

Catolaccus aeneoviridis Gir. possibly is a secondary chalcid parasite, which was obtained in large numbers in the rearings from one of the above primary parasites. It was one of the most numerous hymenopterous parasites taken in the shoebox rearings. The adults emerge from small yellow cocoons on the leaves. The above three parasites were identified by Dr. A. B. Gahan.

Diastichtis fracturalis Zell. is a pyralidid moth which was observed feeding

on bindweed foliage in the larval stage. Dr. A. B. Klots, who determined the specimens, stated that this feeding record is of value.

Oidaematophorus monodactylus Linn. (Fam. Pterophoridae.) (Fig. 4.) This feather-winged moth emerged frequently in the shoe boxes from June to August. It is a dull grayish-brown moth, 11-13 mm. long. Forbes (1923) previously reported this species feeding on plants of this family and that its distribution was nearly world-wide.

Diacrisia virginica Fab. (Fam. Arctiidae). The "yellow bear" caterpillar was taken several times feeding on bindweed foliage.

Neleucania diffusa Walk. A noctuid moth reared from larvae on bindweed, in May.

Prodenia ornithogalli Gue., the yellow striped army worm or cotton cutworm, and *Estigmene acraea* Drury, the salt-marsh caterpillar, were observed occasionally feeding on bindweed foliage in the field.

Tetranychus telarius Linn. The common red spider mite was repeatedly observed on the leaves of bindweed. It was reported killing bindweed at Hiawatha, Kan., in August, 1935. Red spiders, supplemented by the drouth, killed bindweed foliage along roadsides and checked its growth markedly elsewhere on several occasions during these studies. Red spider injury can be recognized by the webbing on the under side of leaves and the tiny gray or reddish mites running about in the webbing. This pest attacks and injures many agricultural and ornamental crops.

Three unidentified species of spiders were taken on bindweed plants during the three summers.

At least one species of yellowish aphid, probably *Aphis nerii* Fonsc. was seen occasionally on bindweed stems. Dr. F. M. Wadley stated in a letter that he had seen this species "clustered thickly on young bindweed shoots in early fall in Sedgwick county, Kansas. Though the infestation was not common, it was fairly heavy where it occurred." Hottes and Frison (1931) list four species of aphids, all of which occur in Kansas, on Convolvulus in Illinois: *Aphis nerrii* Fonsc., *Aphis spiraecola* Patch, *Macrosiphum gei* (Koch) = Solanifolii, and *Myzus persicae* Suez. Doctor Wadley mentioned these species and *Aphis gossypii,* which is also recorded from bindweed, as other possible aphid enemies of bindweed in Kansas.

Loxostege mancalis Led. (or *marculenta* G. & R. Det. Klots) also a pyralidid moth, was observed to feed on the foliage in the larval stage. It was never common. Forbes (1923) records it as a feeder on Convolvulus, Rumex and Mint.

Metriona bivittata (Say), (Fam. Chrysomelidae), is the most common beetle on bindweed. This tortoise or helmet beetle can be recognized by the five narrow black longitudinal stripes on the wing covers. This species attacks morning-glory and sweet potatoes, as well as bindweed, as reported by Blatchley (1910). Both larvae and adults were taken all three seasons. The larvae of this and the next species carry their molted skins in their packs.

Metriona bicolor (Fab.), (Fam. Chrysomelidae), is another common tortoise beetle eating holes in bindweed foliage. The beetle, which is marked irregularly with black, was found frequently on bindweed all three seasons during July and August. The larvae were observed feeding on aphids which occurred on bindweed foliage. The species is a well-known feeder on plants of the

Convolvulaceae. Blatchley (1910) lists morning-glory, bittersweet and sweet potato vines as hosts.

Chelymorpha cassidae Fab. was reared during all years in August from larvae collected on bindweed foliage. They spend approximately twelve days in the pupal stage.

Blatchley (1910) reports the following Chrysomelids, in addition to the above three species, as feeding on Convolvulaceae: *Chelymorpha argus* Herbs (on Ipomoea), *Coptocycla signifera* Herbs (Convolvulus family), *Cassida nigripes* Oliv. and *Typophorus viridicyaneus* Crotch (hedge bindweed).

Jonthonota nigripes (Oliv.), another tortoise beetle, of which both the larvae and adults eat the leaves during the summer, was reared from larvae collected on bindweed in August.

Hippodamia convergens Guer. This common lady beetle feeds on aphids which occasionally occur on bindweed.

Diabrotica duodecimpunctata Fab. The southern corn root worm injures the flowers of bindweed.

Psylliodes punctulata Melsh. (Fam. Chrysomelidae). This common flea beetle, and several others not identified with certainty, occurred in considerable numbers on bindweed. The beetles feed on the foliage. Correspondents have reported this species as feeding exclusively on bindweed, which was injured severely, especially at Bridgeport, Kan., May, 1937.

Chaetochnema pulicaria Welsh. This numerous flea beetle eats the foliage, and the larvae probably feed on the roots to some extent.

Leptinotarsa decimlineata (Say). Both adults and larvae of the Colorado potato beetle feed somewhat on the foliage of bindweed.

Orius insidiosus (Say). (Fam. Anthocoridae.) The insidious flower bug was taken in large numbers on bindweed during the summer of 1935, but was scarce in 1937. It feeds on the eggs, larvae or adults of at least fifty-three insects and red spiders (Marshall 1930).

Ceresa bubalis (Fab.) The buffalo tree hopper is said to feed on the leaves of bindweed, both as nymphs and adults.

Stiretrus anchorago Say. This common predaceous pentatomid bug was taken during July and August, both as nymphs and adults, but especially as nymphs.

Nabis ferus Linn. This common nabid bug is primarily a predaceous form.

Sinea diadema Say is a common assassin bug which is predaceous on other insects.

Chrysopa plorabunda Fitch is a predaceous chrysopid which attacks aphids.

Stagomantis carolina Jan. (Fam. Mantidae.) This predaceous insect was found sparingly on bindweed, searching for small insects for food.

Syrbula admirabilis Uhler swept from bindweed. Grasshoppers, generally speaking, do not feed to any extent on bindweed foliage except when the growth is young and tender. The two-lined grasshopper was the only economic species to be observed feeding on the foliage.

Feeding on Bindweed Seed and Seed Pods

Seed destruction was noticed in many cases. Several kinds of insects eat the seed pods and the blossoms of bindweed. It is not definitely known what insects do the most damage, but among the seed and pod eaters are blister

beetles and an Andrenid wasp. The seed destruction is great enough to be of some importance as an aid in checking bindweed.

Stem and Root-feeding Forms

Subterranean insects were not found to attack bindweed stems and roots to any great extent. Two instances of root feeding by the variegated cutworm (*Lycophotia margaritosa* Haw.) were seen. They devoured the roots of plants but did not kill them. White grubs, wire worms, and some Chrysomelid beetle larvae, probably immature stages of flea beetles, were seen next to the roots, and in some cases were probably doing slight injury to them.

Feeding on the Flowers of Bindweed

Epicauta vittata Fab, (striped blister beetle), *Epicauta ferruginea* Say and *Macrobasis unicolor* (Kisby) (ash gray blister beetle) were observed devouring the corolla of bindweed flowers, but the results in general were not serious to the plants. It would be expected that several other common species may also feed on bindweed flowers. Blatchley (1910) lists *Macrobasis immaculata* Say from wild morning glory and *Epicauta trichrus* Poll on hedge bindweed and sweet potato.

Incidental Visitors and Miscellaneous Parasites

Here follows a group of incidental visitors which are forms collected from bindweed plants but which probably do not feed upon them. The insects were resting on the plants or hiding in the foliage.

Archytas vulgaris Curr. (Fam. Tachinidae).
Mesogramma marginata. (Fam. Syrphidae). Common.
Hypera punctata Fab. (Clover leaf weevil).
Lema trilineata Oliv. (The three lined potato beetle).
Monomorium minimum (Buckley). The tiny red ant.
Leptocoris trivittatus Say. (Fam. Corizidae). The boxelder bug.
Lygaeus kalmii Stål. (Fam. Lygaeidae).

There remains a large collection of small, partly identified parasitic hymenoptera reared in the shoeboxes. The hosts are not definitely known, and it is not known whether they are primary or hyperparasites:

Prigalid sp. Det. Gahan. Aug.
Hattichello sp. Det. Gahan. Aug.
Tricimba (?) *sp.* Det. Gahan. Sept.
Stictopisthus Det. Gahan. Aug.
Tetrastichus sp. Det. Gahan. Aug.
Dicaulotus sp. Det. Cushman. Sept.
A new genus of the family Eucoilinae. Det Man. Aug.
Microbracon mellitor Say Det. Muesebeck. Sept.
Microbracon nuperus (Cress) Det. Muesebeck. Sept.

SUMMARY AND CONCLUSIONS

This study has shown that in the three years in Riley county, Kansas, no insects nor related forms were serious enemies of bindweed. The leafminer, plume moth, and tortoise beetles would be more effective except for natural checks. The fact that the lepidopterous feeders on bindweed are so heavily parasitized offers hope that a similar introduced feeder without its parasites

might exert an effective check upon it. There were no important enemies working on the roots. It is suggested that a root-destroying form would be the most effective kind of natural check. No stem borers were taken. A stem borer might be the next most effective check and both would probably be less parasitized than leaf-feeders.

Blister beetle and other injury to flowers has been inconsequential. In general, most of the bindweed insects are well-known weed insects. This may explain why bindweed mingled with other weeds is attacked more severely by insects than in pure growth stands or in cultivated fields.

The increasing importance of this weed would justify exploration and study by representatives of the United States Bureau of Entomology of the native insects of this weed in its original home. A biological enemy capable of eradicating the weed need not be expected. An effective check which would hinder recovery following cutting off or spraying would be useful though sodium chlorate, which is used to control bindweed, is a strong repellent to the present insect enemies of the plant. Possibly no greater check to the weed from the forms now present in the state can be expected in the future than has occurred during the three dry years of this study.

LITERATURE CITED

CALL, L. E., and GETTY, R. E. The eradication of bindweed. Kansas Agr. Exp. Sta. Cir. No. 101, 18 p. 1923.

FORBES, WILLIAM T. M. The Lepidoptera of New York. Cornell Univ. Agr. Exp. Sta. Memoir 68, 729 p. June, 1923.

FULLER, C. The bindweed gall-maker (*Nupserha apicalis* F.) Agri Jour. Union of S. Africa, Pretoria 8:242-244. Aug. 1914.

HOTTES, FREDERICK C., and FRISON, THEODORE H. The plant lice, or Aphididae of Illinois. Bul. Div. of Nat. Hist. Survey 19 (3): 392. 1931.

KELLY, S. G. The control of Noogoora and Bathurst Burr by insects. Jour. of the Council for Scientific and Indus. Res. 4 (3):161-172. Aug., 1931.

LATSHAW, W. L., and ZAHNLEY, J. W., Experiments with sodium chlorate and other chemicals as herbicides for field bindweed. Jour. Agr. Res. 35 (8):757-767. 1927.

LEONARD, MORTIMER DEMAREST. A list of the insects of New York. Cornell Univ. Agr. Sta. Memoir 101. 1121 p. Aug., 1926.

MARSHALL, G. EDW. Some observations on Orius (Triplileps) insidiosus (Say). Jour. Kans. Ent. Soc. 3:29-32. 1930.

NEWCOMER, E. J. The dock false-worm, an apple pest. U. S. Dept. Agr. Bul. 265. 40 p. 1916.

PADDOCK, F. B. The sugar-beet webworm, *Loxostege sticticalis* Linn. Jour. Econ. Ent. 5:436-443. 1912.

TILLYARD, R. J. The biological control of noxious weeds. Fourth Ent. Cong. of Entomology (Ithaca, 1928) Transactions 4-9. 1929.

TUCKER, E. S. Louisiana records of the bindweed prominent (*Schizura ipomeae* Ddy). Can. Ent. 49:280-281. Aug. 1917.

ZAHNLEY, J. W. and PICKETT, W. F. Field bindweed and methods of control. Kans. Agr. Exp. Sta. Bul. 269, 26 p. July, 1934.

EXPLANATION OF PLATE

1. Side view of the morning-glory leafminer (*Bedellia somnulentella* Zell.), which also mines in bindweed foliage.

2. Larva and pupa of one of the tortoise beetles on bindweed, *Jonthonota nigripes* (Oliv.).

3. A field of field bindweed in full bloom. Photographed June 6, 1937. (Courtesy of Zahnley and Pickett.)

4. Larva of the plume moth, *Oidaematophorus monodactylus* Lum.

5. Fully grown larva of the morning-glory leafminer.

6. Seed pods of field bindweed showing insect damage to pods and seed.

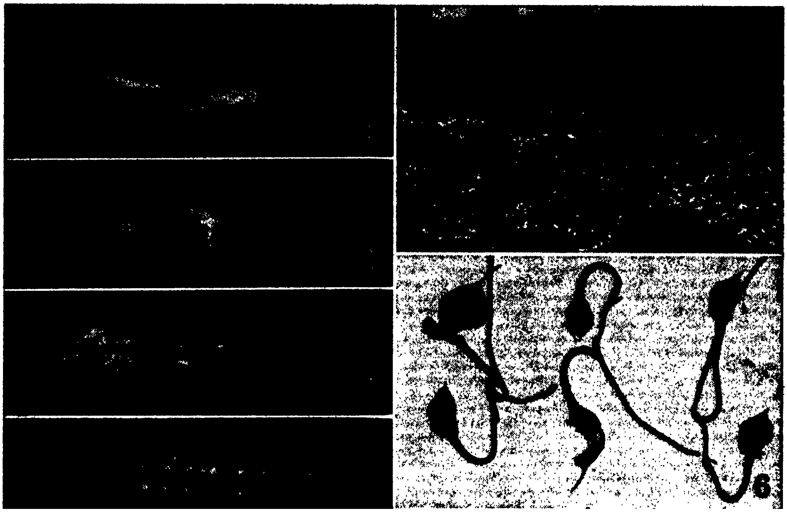
7. Pupa of morning-glory leafminer.

8. Work of the morning-glory leafminer. Note the pupae and frass in the webbing.

9. Cocoon of *Apanteles bedelliae* Vier. the common ichneumon parasite of the morning-glory leafminer.

10. Cocoon from which an adult probably of *Catolaccus aeneoviridis* Gir. has emerged. The host is not definitely known but these cocoons occur commonly on bindweed foliage.

FIGURES 1 TO 10



Cyclical Sedimentation of the Cherokee

G. E. ABERNATHY, State Geological Survey, Lawrence, Kan.

The Cherokee is defined as the lowest division of the Pennsylvanian rocks in Kansas, comprising the beds between the base of the Fort Scott limestone and the upper unconformable surface of the Mississippian rocks. It consists of shales, sandstones, a number of coal beds, and a few thin beds of limestone.

The Cherokee is considered as a group name and is differentiated into formations and members. It has fifteen similar series of beds, which are designated as formations or cyclothems, and each series is divided into beds or phases. The following table shows the divisions of the Cherokee:

Generalized Section of the Cherokee Group

Group	*Formation*
Cherokee	Mulky Bevier Ardmore Croweburg Coalvale Fleming Mineral Scammon Pilot Weir-Pittsburg Knifeton Bluejacket Columbus Neutral Riverton

Cyclical Sedimentation. The Cherokee of southeastern Kansas is made up of divisions, each of which is composed of a similar series of strata (or phases) arranged in the same order, and each such succession is repeated a number of times. The ultimate basis for the divisions of the Cherokee is crustal disturbances which resulted in alternate submergences and emergences of the coal basin that have caused change in the lithologic nature of the sediment, interruption of sedimentation, and occurrence of erosional unconformities. Each division is considered a formation and called a cyclothem, which is defined as the deposits of a single sedimentary cycle (1). A name is introduced for each of fifteen cyclothems recognized in the Cherokee group. In order to indicate properly their genetic relationships and subdivisions, the cyclothems are designated also by whole numbers, and the phases or subdivisions by decimals. The lowest cyclothem of the Cherokee is 1, and the lowest division of the normal cyclothem is 0.1. Therefore, the lowest bed of the Cherokee is designated as phase 1.1, which indicates the position of the phase in the cyclothem and the position of the cyclothem in the Cherokee. The succession of beds at most localities is incomplete and some of the beds

Trans. Kansas Acad. Science, Vol. 41, 1938.

present may be poorly developed. Such beds, however, usually occur in their proper position in the cyclothem at other localities.

The phases of the normal cyclothem in southeastern Kansas are as follows:

Calcareous shale	0.8
Limestone	0.7
Gray shale	0.6
Black shale	0.5
Coal	0.4
Underclay	0.3
Sandy shale	0.2
Sandstone	0.1
Unconformity	

The lower phases of the cyclothem (0.1, 0.2, 0.3, and 0.4) are of continental origin, while the upper phases (0.5, 0.6, 0.7, and 0.8) are of marine origin. The continental sediments are the local accumulations that were derived by the erosion of a near-by land surface. The sediments were carried by streams and deposited in the low places of the basin. There is no transition between the continental and marine phases. The coal bed, the highest phase of the continental sediments, makes a sharp contact with the overlying black shale, the lowest phase of the marine sediments. Phases 0.5, 0.6, 0.7, and 0.8 are the result of the normal advance of the sea upon a continent. The beds of black shale and gray shale (phases 0.5 and 0.6) represent the deposits formed by an encroaching sea. The limestone phase (0.7) represents the time of maximum flooding of the sea. The shale above the limestone (phase 0.8) represents the sediments deposited during the retreat of the sea in the normal sedimentary cycle.

Cyclic Formations of the Cherokee Group

The following table shows the formations or cyclothems of the Cherokee group that have been recognized in southeastern Kansas, and indicates their members or phases.

No.	Cyclothem.	Phase.	Thickness in feet.
15	Mulky	15.7 Limestone	6.0
		15.5 Black shale	8.0
		15.4 Coal "Fort Scott"	2.0
		15.3 Underclay	2.0
		15.2 Sandy shale	40.0
		15.1 Sandstone	11.0
14	Bevier	14.5 Black shale	6.0
		14.4 Coal	2.0
		14.3 Underclay	1.5
13	Ardmore	13.7 Limestone	4.0
		13.3 Underclay	1.0
12	Croweburg	12.5 Black shale	7.5
		12.4 Coal	1.5
		12.3 Underclay	9.0
11	Coalvale	11.6 Shale gray	1.0
		11.5 Black shale	1.0
		11.4 Coal	1.0
		11.3 Underclay	2.2
		11.2 Sandy shale	3 0
		11.1 Sandstone	1.0
10	Fleming	10.8 Shale	2.0
		10.5 Black shale	6.0
		10.4 Coal	1.0
		10.3 Underclay	1.6
		10.2 Sandy shale	12.0
		10.1 Sandstone	1.0
9	Mineral	9.6 Gray shale	1.0
		9.5 Black shale	7.0
		9.4 Coal	1.8
		9.3 Underclay	2.0
8	Scammon	8.8 Shale	2.0
		8.7 Limestone	0.5
		8.6 Gray shale	2.0
		8.5 Black shale	7.0
		8.4 Coal	0.8
		8.3 Underclay	1.5
		8.2 Sandy shale	4.0
		8.1 Sandstone	4.0
7	Pilot	7.6 Gray shale	2.0
		7.5 Black shale	8.0
		7.4 Coal	0.5
		7.3 Underclay	1.0
		7.2 Sandy shale	16.0
		7.1 Sandstone	8.0

No.	Cyclothem.	Phase.	Thickness in feet.
6	Weir	6.5 Black shale	1.0
		6.4 Coal "Weir-Pittsburg"	2.5
		6.4 Blackjack	2.0
		6.4 Coal	0.5
		6.3 Underclay	0.5
		6.1 Sandstone	30.0
5	Knifeton	5.6 Gray shale	16.0
		5.5 Black shale	7.0
		5.4 Coal	0.7
		5.3 Underclay	1.0
		5.1 Conglomerate	1.0
4	Bluejacket	4.7 Limestone	3.0
		4.6 Gray shale	21.0
		4.5 Black shale	4.0
		4.3 Underclay	8.0
		4.2 Sandy shale	12.0
		4.1 Sandstone	20.0
3	Columbus	3.5 Black shale	1.0
		3.4 Coal	1.3
		3.1 Sandstone	28.0
2	Neutral	2.6 Gray shale	5.0
		2.5 Black shale	3.0
		2.4 Coal	1.0
		2.3 Underclay	3.0
		2.4 Coal	1.0
		2.3 Underclay	10.0
1	Riverton	1.6 Gray shale	24.0
		1.5 Black shale	4.0
		1.4 Coal	2.0
		1.3 Underclay	3.0
		1.1 Sandstone	5.0

Characteristics of the Cyclothems and Phases

The cyclothems may be recognized by the cyclic repetition of certain beds called phases which are identified by thickness, color, texture, fossils, and lithologic nature.

Nonmarine sandstone forms the basal phase of eight cyclothems, and each basal sandstone is separated from the underlying cyclothem by an erosional unconformity.

Underclays are present at least locally in each cyclothem except the third (Columbus). The physical properties of most underclays appear to be about the same. Carbonaceous matter and fragments of plant fossils are abundant in the underclay phase of the fifth (Knifeton) cyclothem.

A coal bed is present at least locally in twelve of the fifteen cyclothems. Five of the coal beds are mined, although two of the beds produce more than 90 percent of all the coal mined in the district. The coal beds are remarkably persistent in distribution and fairly uniform in thickness.

Black shale phases are present at least in fourteen of the Cherokee cyclothems. They contain abundant fossils in six cyclothems.

Limestone beds are thicker and more numerous in the upper portion of the Cherokee. Each bed is fossiliferous. Limestone phases are present in five cyclothems.

Marine fossils are abundant in eight of the cyclothems. The greatest number of individuals collected from one cyclothem was from the ninth (Mineral). The greatest number of species collected was 42. The most common species were *Mesolobus mesolobus* var. *lioderma, Mesolobus mesolobus* var. *decipiens,* and *Marginifera muricatina.* The species most diagnostic of cyclothems are: *Linoproductus prattenianus,* abundant only in Cyclothem 9 (Mineral), rare in other cyclothems; *Fusulina,* abundant only in Cyclothem 15 (Mulky), rare in Cyclothem 12 (Croweburg); and *Domatoceras williamsi,* and *Nuculana arata,* occurring only in Cyclothem 8 (Scammon).

LITERATURE CITED

1. Weller, J. M. Cyclical Sedimentation of the Pennsylvanian Period and its Significance. Jour. Geol., 38:101. 1930.

Wanless, H. R., and Weller, J. M. Correlation and Extent of Pennsylvanian Cyclothems. Geol. Soc. America, Bull., 43:1003—1016. 1932.

Moore, R. C. Stratigraph Classification of the Pennslyvanian Rocks of Kansas. Kan. Geol. Survey Bull. 22:21-38. 1935.

The Fossil Beds of Northwestern Nebraska as Observed on the McPherson College 1937 Summer Biology Trek

PHILIP BRUCE DAVIS, McPherson College, McPherson, Kan.

"Are *all* those *real bones?*" "Now, just why are you burying them in that big block of plaster?" "How many animals could you make from all those bones?" "Say, have you found any monkey men in that block yet?" During the past year more than 1,022 persons from 27 states and 7 foreign countries have passed through the McPherson College Museum. Many of the uninitiated asked such questions.

These visitors were all standing before a slab of white sandstone approximately 4 feet square and 18 inches thick. Projecting from the surfaces of this block are more than 700 fossil bones which have been exposed by carefully chiseling away the matrix which contains them. Predominately the bones are those of a Miocene rhinoceros, with some of the giant swine, and a few of the exceedingly rare Morophus. This slab of fossil-bearing rock, along with hundreds of other individual bones in a remarkable state of preservation, was taken from the world famous Agate fossil quarries near Agate Springs, Neb., by the McPherson College Midsummer expedition of 1937.

This expedition to interesting geologic localities in northwest Nebraska and adjacent states, led by Professor R. E. Mohler, head of the department of biology of McPherson College, was composed of Mr. C. H. Dresher, science instructor in the McPherson city schools, and eight students, Charles Wagoner, Lloyd Moehlman, Aluin Goering, Fred Nace, Willard Brammel, Alvin Lindgren, Philip Davis, and Richard Mohler.

The Agate fossil quarry merits extended attention. As the story goes, about sixty years ago James H. Cook, the present owner of the quarry, while riding on horseback over his claim, with his sweetheart, in the little valley of the Niobrara river, noticed some large bones sticking out the side of one of two closely connected hills left stranded by the processes of erosion in the valley to the south of the river. During his earlier life as a cowpuncher and scout in the Indian wars he had heard tales of so-called "petrified bones," but had never seen any. His first thought was that he had discovered an Indian burial ground and that the bones were those of some Indian's horse, but examination proved the bones to be unlike those of the horse; in fact, unlike those of any animal with which Cook at the time was familiar. Cook began to excavate, but soon realized he was not adequately equipped for the task. A paleontologist was called in, who, after a short investigation, recognized that here was a rare find, destined to become known as one of the richest fossil beds in North America. The bones, incidentally, were those of a new species of rhinoceros, which was named *Diceratherium cooki* in honor of the discoverer of the quarry. Many large offers were made to Cook in attempts to buy the quarry outright, but Mr. Cook wisely chose to retain control and operate the quarry, as at present, on the principle of allowing properly equipped and qualified educational institutions the privilege of taking out materials, subject to the single condition that such materials would not be sold. As a result, the Agate quarry has been very extensively worked by both American and European parties. The Smithsonian Institution at one time

worked the Agate beds for twenty consecutive seasons. Nebraska U., Colorado U., Carnegie Tech., the American Museum, and the Yale Peabody Museum all have extensive collections from the quarry. Materials from Agate have attracted the widespread attention which they deserve and are now exhibited in the major museums all over the world.

Three types of fossil remains predominate the fauna of the quarry. The most abundant remains are those of the Miocene rhinoceros, *Diceratherium cooki,* which are limited to the Agate beds. The Terrible Boar, *Dionyhyus hollandi,* which stood six feet at the shoulders and weighed probably 1,500 pounds, is abundantly represented. The least common of the three major types is Morophus, a peculiar beast lying in the common ungulate ancestry of the horse and llama. Morophus stood eight feet at the shoulders and displayed some of the most interesting evolutionary adaptations which are to be found, as, for example, the extreme modification of the cervical vertebrae to provide leverage for crushing pressure downward rather than upward with the head and neck, and the development of flexibility by modification of the wrist after fusion of the bones of the forearm had taken place. Morophus is found only at Agate, two complete skeletons having been found there, in addition to isolated bones.

It is almost impossible to describe the great abundance of these fossils in the bone stratum. Suffice it to say that in many areas it would seemingly be difficult to remove one bone without cutting through others lodged around it. The great wealth of the beds may be suggested by the fact that from the extensive excavation which has been done it is estimated that in one of the two hills the remaining strata, covering about three acres with an average depth of 15 inches, contains over 20,000 rhinoceros skeletons and 6,000 giant swine.

The bone horizon, or the fossil-bearing mother stratum, runs through the two hills, Carnegie Hill to the south, University Hill to the north, at a depth of about 70 feet from the top surface, varying in thickness from 12 to 18 inches. The quarry is worked by uncovering the stratum and removing the individual bones or entire sections of the sandstone layer itself. As the work has progressed the excavations have eaten toward the center of the hill, making the task of further excavation more difficult because of the greater amount of material above the stratum to be removed and the greater distance it must be carried to dump it over the side of the hill. If large sections of the stratum are to be removed it is now necessary to blast off about 50 feet of overlying sand and limestones.

In procuring the McPherson slab it was unnecessary to blast, as it was possible to undercut with hand picks and shovels an irregularity in the face of the cliff. As this was done, the loosened material was placed on the bed of a small truck, which was backed to the edge of the hill and dumped. When an area of the stratum about five feet square had been uncovered a four-foot square was cut out by carefully picking down through the stratum to the underlying sandstone. The slab was then sawed loose from the supporting rock by the use of a length of barbed wire, turned up and completely enveloped in a thick plaster cast reinforced with burlap strips, later crated and brought to McPherson. Today the chalk-white slab with its more than 700 bones jutting from its surfaces stands ready to be covered with its new glass case, a sight perhaps more thrilling to the confirmed "bone hunter" than to the average skeptical museum visitor.

A Subsurface Study of the Black Shales of Western Kansas

GLEN H. GORDON, Wichita, Kan.

Black shales are often found in well cuttings and cores from the deep wells of western Kansas. They are frequently conspicuous because of their marked contrast in color to the associated limestones and light-colored shales. Some of these thin black beds are of wide lateral extent and possess fairly constant lithologic characteristics. Therefore, when their positions are known they may prove to be of value in a more accurate determination of the commonly used stratigraphic markers. They are of greatest value in those parts of the section where they are relatively rare and are separated by rocks of an entirely different nature; here the identification of the separate beds is greatly simplified.

The chief disadvantages in using black shales for correlations are that they may pinch out or change abruptly in lithology. In almost every pool there are thin beds, often less than one foot in thickness, which give traces in the cuttings that may be of value in local correlations but can seldom be traced to wells a few miles away. Shales of this type are found in the Wellington, Wabaunsee and Douglas. In this paper shales that can be traced less than forty miles are given only very brief mention.

The origin of the black shales in the Pennsylvanian of Kansas is described by Dr. R. C. Moore (1) as follows:

"The association of these black shales with marine beds, their wide distribution, notwithstanding thinness, and the occurrence of marine fossils indicate origin in the sea. The black color is due to finely divided, disseminated iron sulfide and to much partly decomposed plant matter. An acid and toxic environment is indicated by the nature of the plant debris, the presence of sulfides, and the restriction of the scanty invertebrate fauna to a few generally depauperate mollusks, lingulid and discinid brachiopods, with addition of *Ambocoelia* and other resistant types, conodonts, and planktonic organisms. The plants may represent sea weeds, but may also include land-derived types. The conditions suggest stagnation not unlike that of the coal swamps and quiet, undisturbed sedimentation of a humus muck. Extremely shallow water, with sunlight promoting abundant plant growth and aiding in partial decay, with too little depth for circulation and effective wave or tidal agitation, seem to offer the environment required. The quiet of moderate deep water, below the zone of effective wave agitation, lacks other environment requisites unless, conceivably, the pecular conditions of enclosure and lack of circulation reported in the Black Sea existed."

The thicker black shales, as the Chattanooga and the Cretaceous shales, are probably the products of slow subsidence of the sea floor, deposition keeping pace with subsidence and thus keeping a constant environment for long periods of time.

The method used in studying black shales was to correlate, on the commonly used markers, many detailed sample logs from the files of various oil companies. When a black shale was found that could be traced for forty or more miles, that occurred at the same level in widely separated wells, the samples were closely examined for distinctive lithologic features and diagnostic fossils. Less persistent shales were given brief study. In this way the work of several years was reviewed in a few weeks.

Trans. Kansas Acad. Science, Vol. 41, 1938.

Unfortunately most of the Pennsylvanian shales are without sufficiently distinctive characteristics to make their identification positive, so they must be recognized largely by their position in the section.

A few of the beds carry through from the outcrops in eastern Kansas, showing much the same thickness and lithology on the central Kansas uplift as found on Doctor Moore's columnar sections measured along the Missouri river (2).

The best part of the section in this respect is the lower Shawnee, every member of the Oread being recognizable with a fair degree of certainty over much of Russell, Barton, Ellis and Ellsworth counties.

A brief description of the black shales of western Kansas, beginning with the oldest, follows:

Pre-Sylvan: There are no true black shales of any extent below the Sylvan, but in several wells a black Pre-Cambrian schist that may be mistaken for shale has been penetrated to great depth. Schistose material may be recognized by its lack of fossils, its thin flakes containing oriented crystals of ferromagnesian minerals, and frequent shiny metallic cleavage faces of graphite. An interesting graphite schist section was drilled by the Blair No. 1 Fink well in section 16, T. 14 S, R. 14 W, Russell county.

In the Simpson there are thin zones of dark gray to black shale, but they are quite rare and unimportant, most of the Simpson shale being green.

The Sylvan or Maqueketa shale, the uppermost Ordovician formation, 0 to 125 feet in thickness, may rarely carry black shale. The Sylvan-Maqueketa is present in the structural basins of central and southwestern Kansas. It is sometimes a soft, gray shale, but is usually fairly hard and dolomitic; occasionally it is cherty. It contains the only graptolites reported in Kansas, mostly Diplograptus and Climacograptus. Specific determination of the graptolites is unnecessary for they are found only in this one formation.

The Chattanooga shale or Kinderhook is the lowest Mississippian of Kansas, 0 to 250 feet thick, is frequently black (the name Chattanooga is usually applied to the black phase of the basal Kinderhook). It contains abundant small, brown spores (*Sporangites huronense*), conodonts, and *Lingula*.

The Cherokee shale, the lowermost Pennsylvanian of Kansas, 0 to 500 feet in thickness, contains much black shale, so much in fact that correlations are best made on the limestone beds which frequently contain fusulinids. There are no commonly used markers in the Cherokee of western Kansas.

An interesting discovery in the Cherokee was a species of large, flabby-looking plant spores, much larger than those of the Kinderhook. These spores were found in a black Carbonaceous shale fifteen feet above the Mississippian in the Alma-McNeeley No. 1 Watchorn well in section 13, T. 15 S., R. 33 W., Logan county. Similar spores were found in the Bates & Trigg No. 1 Nimochs well in section 16, T. 16 S., R. 28 W., about thirty miles southeast of the first well. These spores were in a light micaceous shale 150 feet above the Mississippi lime. As these spores were abundant in both zones there is a possibility that when more wells are drilled in this area spores may become important fossils in the Cherokee.

The Marmaton, like the Cherokee, contains black shales. Here, too, correlation is based on fusulinids. Mr. Robert Roth (3) worked a section of the Marmaton and Cherokee for western Kansas, Nebraska and eastern Colorado,

using fusulinids as index fossils. The thickness of the Marmaton is 0 to 300 feet, of which about one fourth may be soft, dark gray to black, frequently sandy, shales.

The Lansing-Kansas City-Bronson, mostly limestone, may contain up to eight black shale breaks, in western Kansas, or there may be none. However, most of the shales are found to fall into five fairly distinct zones, approximately 40, 90, 160, 250 and 300 feet below the top. The lower zones are not present on major uplifts. The 160-foot zone is the most persistent and the 40- and 90-foot zones are in a tie for second. The most prominent oölitic zone is usually between the 90 and 160 foot zones. If the bed used as the top of the Lansing in western Kansas is the top of the Stanton and if there has been no appreciable truncation over most of this area a suggested correlation for the area where there is no noticeable shale break between the Lansing and Kansas City formation is: the 40 foot zone may be the Eudora, it seems to be about two to five feet thick; the 90 foot zone would then be at about the level of the Hickory Creek shale in the Plattsburg limestone. The 160 foot bed, sometimes 15 feet thick, would then correspond to the Quindaro or the top of the Lane shale. The main oölitic zone would then be in the Wyandotte limestone and would correspond to the Farley. The 250 foot zone might correspond to the Quivira shale and the 300 foot zones may be the Stark or the Hushpuckney shale or both. It varies in position and may take in both. These shales are mostly thin, black, fissile, and sometimes slightly calcareous, they look very much alike.

The Douglas group, 0 to 300 feet in thickness, contains only a few very thin nonfossiliferous black shales, none of which seems to be very persistent.

The Shawnee group appears to contain seven distinct black shales that are of more than local importance, as well as four or five thinner ones. The more persistent ones occur about 30, 70, 110, 145, 170, 225 and 260 feet above the base of the Oread, where the Shawnee is quite thick there are several thin ones higher up. The 30 foot zone is almost certainly the Heebner, the fusulinids of the Leavenworth are found below it and the chert of the Plattsmouth above.

Just above the Plattsmouth chert is another black shale, the Heumader, the 70 foot zone. These two shales may be traced entirely across the state and west to Colorado. The 110 foot zone should fall in the Jackson Park shale, the 145 foot zone in the Stull shale, the 170 foot zone, which is quite strong, should be the Queen Hill. The 225 foot zone is rather vague and may be several thin shales in the Tecumseh. The 260 foot zone seems to be the Larsh-Mission Creek. A thin, black shale, about ten feet below the top of the Topeka, is probably the Holt shale. These shales are all soft and fissile, there seems to be no way, with the possible exception of condonts, which are quite rare, to tell cuttings of these shales from those of the Kansas City-Lansing.

Wabaunsee-Big Blue: There are three fairly persistent black shale zones between the base of the Tarkio and the top of the Topeka. One 20 feet above the Topeka and below the Howard is in the Severy shale at about the Nodaway coal horizon. One about half way between the two markers is at about the Elmo coal horizon. The third, 20 feet below the Tarkio, must be in the Willard Shale.

There are four black shale zones between the base of the Neva and the Tarkio. One of these, ten feet above the Tarkio, is at the level of the coal

zone in the Pierson Point shale. Another comes at about the Lorton coal horizon. The third zone is in the Admire and is quite vague. The strongest one of these four is 25 to 40 feet below the base of the Neva, probably in the Burr limestone or upper Roca shale.

There are no black shales in the remaining Palezoic beds that are comparable in strength or persistency to those already mentioned. However, thin local beds were found 40 feet above the Neva, probably in the Eskridge, 20 feet below the base of the Wreford in the Speiser or the Blue Rapids shale. The Havensville shale in the Wreford was dark gray to black in some areas. A few thin, black shales were found in the Wellington; there were three of these in the Atlantic No. 1 Vaniman well in section 15, T. 20 S., R. 33 W., Scott county.

The Kiowa shale seems to pinch out or change to a sand a short distance west of the outcrop line, if it were present in its surface form as a sticky, fissile, highly fossiliferous, black shale it should be quite conspicuous; but over most of the area west of the outcrop shales of this type are not found at this level.

In the Cretaceous the Pierre, uppermost Cretaceous of Kansas, is found only in the far western counties, up to 1,200 feet may be found, much of which is black. The shale is soft and sticky, contains bentonite and *Inoceramus* shell prisms.

The Blue Hills shale in the Carlile may be black, but is a poor marker, as it grades gradually into the Fairport chalky shale member. The Carlile is plotted as a single unit and is usually recognized by its position and *Inoceramus* prisms.

The Granerous shale, about forty feet thick, is a soft, gritless, frequently gypsiferous shale, its microfossil content is negligible. In general, the shales of the Cretaceous are rather unimportant, being recognized almost entirely by their positions with regard to the limestone and sandstone markers.

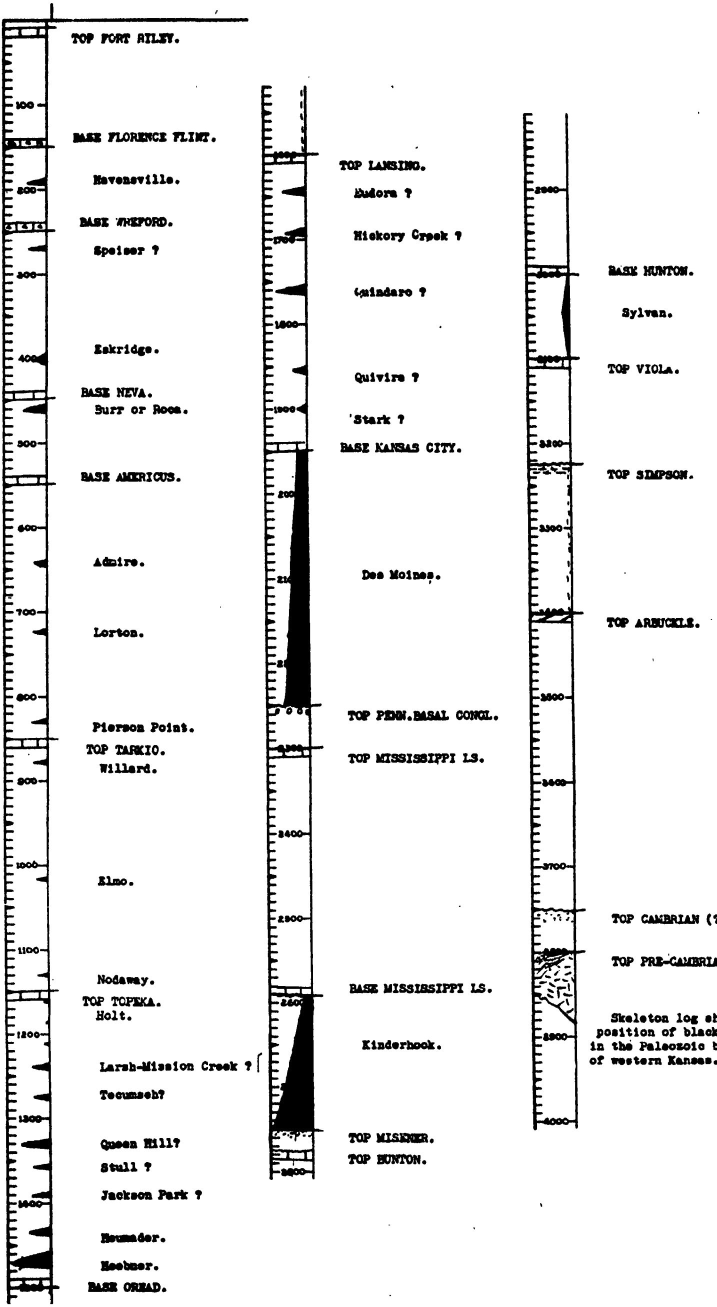
CONCLUSIONS

1. The Chattanooga is characterized by abundant spores.
2. Black shales, because of their abundance, are of small value in correlating the western Kansas phase of the DesMoines series with the outcrops.
3. Black shales offer a possible means for correlation of the western Kansas beds with the outcrops in that part of the section from the Neva to the base of the Kansas City.
4. Black shales are unimportant from the Neva up to the Graneros.
5. The Cretaceous shales are poor markers and are recognized largely by their relation to other beds.

LITERATURE CITED

1. Moore, R. C., Environment of Pennsylvanian Life in North America. Bull. Amer. Assoc. Petrol. Geol. 13; 465-66. 1929.
2. ——— Pennsylvanian and Permian Rocks of Kansas. Kansas Geol. Survey, one sheet.
3. Roth, Robert, Regional Extent of Marmaton and Cherokee Mid-Continent Pennsylvanian Formations. Bull. Amer. Assoc. Petr. Geol. 14; 1249-78. 1930.

Confer also many of the bulletins of the Kansas Geological Survey and the Guide Books of the Sixth, Tenth and Eleventh Annual Field Conferences of the Kansas Geological Society.



Skeleton log showing position of black shales in the Paleozoic beds of western Kansas.

A Recent Sink Hole Near Potwin, Kan.

GLEN H. GORDON, Wichita, Kan.

On the afternoon of September 22, 1937, a sink hole was suddenly formed on the George Wilkinson farm, in the southeast quarter of section 24, township 24 south, range 3 east, near Potwin, Kan. This depression was given a lot of newspaper publicity; its size was tremendously overestimated, its rate of growth was reputed to be fearsome; it was expected to cut state highway number 194 about a quarter of a mile away at any time. The unfortunate town of Potwin seemed to be directly in its path, tottering on the brink only a mile and a half from the edge. The ballyhoo given this depression was so great that a picture of the hole was published in at least one newspaper in England. In Wichita it ranked as one of the biggest news stories of the year.

Because of the great interest aroused by the hole, a few of us from the University of Wichita, under the leadership of Dr. Walter A. VerWiebe, decided to investigate the area. We were courteously welcomed by Mr. Charles A. Joseph, who owns the farm just south of the depression.

The hole, then about twenty-four hours old, was almost as large as it is at present, 90 by 150 feet, the long direction being almost straight east and west. The sides were almost perpendicular, being made of rich black unstratified loam, evidently recent and probably deposited by wind and stream action. The brink is 35 feet below the base of the Herington limestone, which may be plainly seen in the hill to the north. Therefore, the Winfield limestone, which is eroded away would, if present, come near the ground level in the valley where the sink hole was formed. The Towanda, which must also be cut away, would come a few feet below the bottom of the hole.

It seems that the cause of the depression must be the caving in of the roof of a cavern in the underlying Fort Riley limestone, the top of which would be less than 75 feet below the bottom of the hole. The Fort Riley is the uppermost soluble bed of sufficient thickness to provide a cavern large enough to hold the missing soil, about 500,000 cubic feet. The Fort Riley in this area is broken by vertical joints which run entirely through the member in some places. These cracks allow ground water to seep into the formation and also weaken the roof of any cavern formed, permitting it to cave in under the weight of the overlying beds. That the Fort Riley is soluble in water may be seen on the outcrops; flat saucerlike depressions formed by standing water are common. Other sink holes have been reported from this formation, (1) and the Fort Riley is known to contain water in this region. There is a possibility that the solution caverns may reach down into the underlying Florence flint, for the Oketo shale, which is found between these formation farther north, is missing here.

The hole was filled to within fifteen feet of the top with clear, green water, which appeared to be quite still. The water was evidently ground water from the loose loam of the valley. As it was rumored to be bottomless, I decided to try diving to the bottom. The water was no colder than that found in creeks at that time of the year, about 60° I estimated. The bottom

in the deepest place was found to be about 27 feet below the surface, the average depth was approximately 20 feet. Therefore, the greatest depth of the hole was about forty feet or a little over.

This depression is well suited to study in that it is readily accessible by good roads and is in an area where much geological work has been done and the geologic section is well known. There are at least two other partly filled sink holes in the same section, and the cycle of youth to old age may be seen here. In reaching maturity the banks remain nearly vertical, but continue to cave around the edges, the cavings falling into the hole and gradually filling it up while the banks move slowly outward until the hole is so nearly filled up that they disappear.

Sink holes are common in Kansas. Many of them are found in the gypsum area of Barber county and the surrounding counties. Bass (4) and Landes (3) have described a sink hole in the Cretaceous rocks of Hamilton county. Moore (5), Russell (6) and Elias (7) have described a sink hole in Wallace county. The Eleventh Annual Field Conference of the Kansas Geological Society visited an interesting sink hole in the Cherokee shale, exposing the underlying Mississippi limestone. (Stop 6, NE¼, sec. 9, T. 32 S., R. 25 E., Cherokee county.) This one was associated with a fault. Sink holes are also common in Missouri, Illinois, Kentucky, Tennessee, Virginia, Florida and other states (8).

The formation of the caverns which cave in to form sink holes is generally believed to be caused by the dissolving action of water carrying carbonic acid derived from the air, and of acid formed by decaying organic matter. The beds dissolved have usually been exposed for a long time at or near the place where the caverns are formed. Joints, faults, and cleavage planes aid the water in gaining admittance to the beds. Porous and fractured beds expose more surface to the action of the solvent and thus are dissolved faster than solid formations.

Sink holes vary in depth from a few feet up to over two hundred feet; their length and breadth also varies widely. One observed near the natural bridge south of Sun City was less than two feet wide. Wallace Lee (9) describes sink holes over half a mile long in the Rolla Quadrange of Missouri. Occasional depressions, quite shallow, with sloping sides and miles in extent, forming broad basins instead of steep-sided sink holes, are known.

Sink holes may form under streams and divert their water into underground channels. Such streams may carry stream gravel and sand from the surface beds into the underlying formation, and such a cavern, if buried, might prove a difficult problem when drilled into by a deep well. One of the wells south of the Bemis Pool in Ellis county is reported to have gone into a cavern full of weathered white chert, seemingly derived from the Mississippi lime, well within the Arbuckle Dolomite.

There is good reason for suspecting that there are many caverns and sink holes on the buried Arbuckle and Mississippi lime surface of Western Kansas. Rotary wells frequently drill into caverns and lose circulation, the mud fairly dropping out of the hole. Vast quantities of straw, cotton seed hulls and cement have been put in these holes in the attempt to regain circulation. Another evidence of sink holes on the Arbuckle surface is found in one of the Deep Rock Oil Company's Baumer wells in the NE, SW, NE, of section

27, T. 11, R. 17 W. This well has producing wells on three sides, these producing wells do not vary more than five feet in their elevation on the Arbuckle, but the low well is 270 feet lower than the lowest of these. Other low wells are found scattered all over the central Kansas uplift. Many of these may be accounted for by topography, but sink holes and caverns seem to be the solution to some of the deeper ones.

When a cavern is buried by several hundred feet of sediments containing no competent beds, continued dropping in of the layers directly over the hole might be expected to make the top of the cavern approach the surface as the bottom was filled up until the cavity was close enough to the surface for the overlying beds to cave in and form a sink hole.

CONCLUSIONS

1. Sink holes are believed to be caused by caving in of caverns in soluble rock. These caverns are caused by ground water.

2. The dimensions of the hole are governed by the size of the cavity. The depth of the hole is governed by the thickness of the dissolved formation, except in those holes where the debris is removed by flowing water.

3. Subsidence may be fast or slow, depending upon the nature of the beds involved. Usually the subsidence is rapid and the hole begins to fill up immediately following a regular cycle of maturity.

4. Sink holes are believed to be present in most soluble beds that have been long exposed at the surface regardless of their present depth of burial.

5. Solution caverns under incompetent beds may reach the surface from great depths.

LITERATURE CITED

1. FATH, A. E. Geology of the El Dorado Oil and Gas Field. Kansas Geological Survey Bulletin 7:49-54. 1921.

2. BASS, N. W. Geologic Investigations in Western Kansas, Pt. 2; Geology of Hamilton county. Kansas Geological Survey Bulletin 11:74-76. 1926.

3. LANDES, K. K. Recent Subsidence, Hamilton county, Kansas. Bulletin American Association of Petroleum Geologists 15:708. 1931.

4. BASS, N. W. Recent Subsidence in Hamilton county, Kansas. Bulletin of the American Association of Petroleum Geologists 15:201-05. 1931.

5. MOORE, R. C. Note on Subsidence near Sharon Springs, Wallace county, Kansas. Kansas Geological Survey Bulletin 11:95-96. 1926.

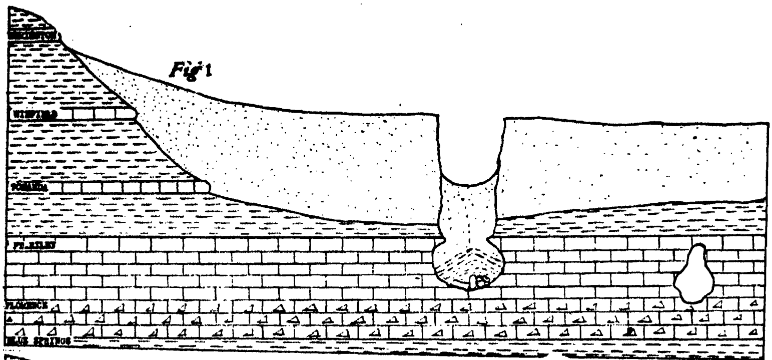
6. RUSSELL, W. L. Local Subsidence in Western Kansas. Bulletin of the American Association of Petroleum Geologists 13:605-09. 1929.

7. ELIAS, M. K. Orgin of Cave-ins in Wallace county, Kansas. Bulletin of the American Association of Petroleum Geologists 14:316-20. 1930.

8. DAKE, C. L., and J. S. BROWN. Interpretation of Topographic and Geologic Maps, McGraw-Hill Book Company, New York. 1925.

9. LEE, WALLACE. The Geology of the Rolla Quadrangle. Missouri Bur. Geology and Mines, 2d ser., 12:65-67. 1914.

THE POTWIN SINK HOLE



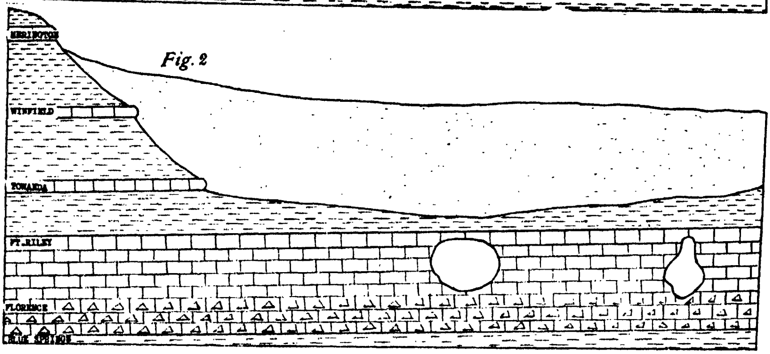


FIG. 1. The Potwin sink-hole area after subsidence.

FIG. 2. A generalized cross-section of the Potwin sink-hole area before subsidence.

The Chert Gravels of the Kansas River Valley Between Lawrence and Kansas City

WM. K. MAC FARQUHAR, University of Kansas, Lawrence, Kan.

ABSTRACT

In the northeastern or glaciated part of Kansas are numerous deposits of chert gravels with which are associated glacial erratics. The present studies are limited to the gravels in Leavenworth county. For the most part, the gravels consist of buff-colored chert or flint fragments which range in size from one to six inches and whose edges are commonly smooth and rounded. The gravel deposits occur on the higher slopes, from 100 to 150 feet above the present level of the Kansas river flood plain.

The gravel deposits have been considered to be residual in origin. According to Haworth, they represent the chert which accumulated by the removal of approximately 500 feet of overlying strata. Todd, on the other hand, believes that the chert gravels were carried in by streams coming from the west in pre-glacial times and thus mark the former levels and positions of stream channels. The presence of glacial erratics, especially in the upper portion of the gravel deposits, suggests that, if not entirely, part of the gravels are associated with streams coming from the Kansan ice sheet. Further studies, it is hoped, will yield more data pertaining to the distribution and origin of these interesting chert gravels.

Trans. Kansas Acad. Science, Vol. 41, 1938.

Terrace Sands of Eastern Sedgwick County, Kansas

LOUIS MICHAELSON, Gulf Oil Corporation and University of Wichita, Wichita, Kan.

The purpose of this paper is to present a geological problem which has arisen relative to the possible age of terrace sands found in eastern Sedgwick county. It is not the intention of the author to state the age of this horizon, but rather to present the known facts and allow others to come to their own decisions. Frankly, the writer is not prepared to publish his own conclusions, believing that further field work covering a larger area is essential.

ACKNOWLEDGMENTS

During the field work much friendly help was received from Dr. Walter A. Ver Wiebe, who gave information leading to the finding of many outcrops. Thanks are due to Glenn Gordon for field assistance on many occasions. During the preparation of this report many helpful suggestions were made by Carl Barnhart and J. M. Jewett.

AREA

The area studied lies chiefly in Sedgwick county, and extends from the Big Arkansas river eastward to the Sedgwick-Butler county line, and covers townships 24 to 29 south, ranges 1 and 2 east. The area in township 24 south is in Harvey county.

METHOD OF WORK

The method of locating outcrops was to drive or walk along section-line roads and creeks and inspect railroad cuts. Measurement of location was accomplished either by pacing or speedometer readings. All available logs were examined to give subsurface localities.

Samples of sand and conglomerate were taken at each outcrop. Care was taken that enough of the surface was cleaned away so that the sample obtained was not contaminated. The laboratory procedure in determining the mineral content of each sample was to examine the material under a microscope. If calcium carbonate obscured too much of the sample it was broken up and placed in acid, and the clean sample then examined.

The accompanying map was prepared by the writer to show the outcrops of the terrace sands, as well as the location of wells in which it is reported by drillers.

STRATIGRAPHIC RELATIONSHIP

Terrace sands may or may not be overlain by alluvium. Where the base is exposed, they overlie beds of Wellington age. The horizon is composed of sand at the top and conglomerate at the base. Throughout the area the conglomerate unit is always present and ranges in thickness from six inches at the north to from 4½ to 5 feet at the south. The sand member is not always present. Its thickness ranges from 1 to 1½ feet.

Trans. Kansas Acad. Science, Vol. 41, 1938.

LITHOLOGY

The terrace sands of this horizon range from yellow to a deep earthy brown color. They have no cement. Their minerals, feldspar, quartz, and some jasper, are identical with the minerals in the conglomerate. In fact, no definite line can be drawn between the sand and conglomerate members, excepting that the sand, when present, is on top of the conglomerate. Probably this is all one and the same bed, with the lower parts cemented by calcium carbonate. In color, mineral content, size and shape of grains the sands resemble the sands of the McPherson Equus beds, as found in the sand pits of McPherson county.

Conglomerate is a relatively soft bed and rarely forms a distinguishable bench. This contrasts with the Ogallala to the west, since this formation forms a prominent escarpment. The conglomerate is usually a light grey to brown in color. In some places it is so filled with calcium carbonate as to be nearly white. The rock usually is full of scattered grains of colorless quartz. Grains vary from fresh to frosted in appearance. They may be well rounded, but are usually subangular and frosted. The feldspar and jasper show severe weathering. Locally, at the bottom of the conglomerate, and extending a foot or more above the base, may be found interbedded fragments of Wellington shale, claystone, limestone, and calcite, with cone-in-cone structure. These fragments were possibly picked up by the streams which cut into the Wellington formation. At one locality a thin bed of aragonite is present at the very base of the conglomerate.

While not common, banding in the conglomerate is present at some places. This is caused by the interbedded zones of predominantly large and small grains. The best outcrop showing this banding, together with some cross-bedding, is near the town of Furley, in section 10, T. 25 S., R. 2 E. Here the horizon has a thickness of about 1½ feet and shows the effect of swift currents.

DESCRIPTION OF IMPORTANT LOCALITIES

The locality having aragonite at the base of the conglomerate (sec. 33, T. 24 S., R. 1 E) is interesting because of the presence of a few bone fragments. They are too badly weathered to permit identification. Again, in the northwest corner of sec. 24, T. 27 S., R. 2 E., more fossil fragments were found which could not be identified. J. M. Jewett, of the State University of Kansas, found a tooth here. Probably it came from a horse, but it has not yet been positively identified.

The best outcrop in the area covered by these terrace sands and conglomerates occurs one half mile north of Connell flag station in sec. 11, T. 28 S., R. 1 E. Here the horizon is 4½ feet thick. No trace of fossils could be found.

An unsuccessful attempt was made to find the outcrop three miles northeast of Wichita, described by Robert Hay[1] as being along the Frisco railroad. Probably this failure was due to the incompleteness of Hay's description.

SUBSURFACE STUDY

After all known surface outcrops had been examined a study was made of all available well logs. This proved rather satisfactory, although the information came from drillers' logs. In most cases samples were not saved high

1. Robert Hay, Bulletin 57, U. S. G. S., page 34, 1890.

enough to be of benefit. Wells encountering terrace sands and conglomerate are shown on the map, with depths where they found and passed through this horizon. Many of the logs report water in this horizon.

AGE AND CORRELATION OF THE TERRACE SANDS

When this research problem was undertaken it was thought that possibly the age and correlation of these beds could be established by mineral content or fossil remains. Neither of these has proved anything to date.

Haworth and Beede,[2] in their report on "The McPherson Equus Beds," stated that Dr. G. P. Grimsely found no feldspar in specimens of this sand. However, the writer found feldspar quite common in the Equus beds at several localities in McPherson county.

At least two published statements give different ages and correlations for these terrace sands. Haworth[2] (page 287) says that the "Tertiary grit" referred to by Hay just east of Wichita is probably an outcrop of the McPherson Equus beds. On the other hand, Plummer[3] in describing the pit at the United Brick and Tile Company (one of my localities), considers the terrace sands in this locality equivalent to the Ogallala formation.

No fossils could be found at any locality which could be identified sufficiently to establish any age correlation. It is thought best, therefore, to give the arguments for and against a Quaternary (McPherson Equus beds) age or a Tertiary (Ogallala) age.

QUATERNARY AGE: The McPherson Equus beds have been definitely traced southward almost to my northernmost outcrop. The cross-bed of the terrace sands seems to indicate that the current of water came from a north-northwest direction. Since the drainage of the McPherson beds was to the south, this cross-bedding would tend to indicate that the terrace sands were a part of the McPherson beds. It is generally accepted that the Little Arkansas river flowed southward from an old lake which the McPherson formation now occupies. In texture the terrace sands more closely resemble the McPherson Equus beds than the Ogallala formation.

TERTIARY AGE: During the Tertiary, streams flowing eastward across Kansas, including the Big Arkansas river, were overloaded. Evidence has been found that the Arkansas river channel at one time was farther east than it is at present. Since these eastward flowing Tertiary streams carried a heavy load, it is probable that during floods this load would be carried sufficiently far east to be deposited in the terrace sand area east of the present Big Arkansas river. The conglomerate beds are only a few inches thick in the northern part of the county and several feet thick in the southern part of the county. This seems to indicate that the conglomerate came from the west rather than from the north. The state geological map indicates Ogallala in the western part of Sedgwick county. If this formation extends this far east, it is quite possible it extends a little farther east and includes the terrace sands of eastern Sedgwick county.

---

2. E. Haworth and J. W. Beede; State Geol. Sur. Kan., vol. 2, pp. 289, 1897.
3. Norman Plummer; State Geol. Sur. Kan.; Min. Res. Cir. 5; pp. 50, vol. 38, No. 5, 1937.

CONCLUSION

The terrace sands of eastern Sedgwick county occur between a 1,300- and 1,400-foot elevation. It has been found impossible to trace these beds very far in any direction. Their mineral content, the lack of identifiable fossil remains, and the record of wells all tend to add to the difficulties rather than lessen them. Unfortunately, the present exposures do not permit tracing these beds northward into the McPherson Equus beds or westward into the Ogallala. Until more conclusive evidence has been found, the age and correlation of these terrace sands must be left unsolved.

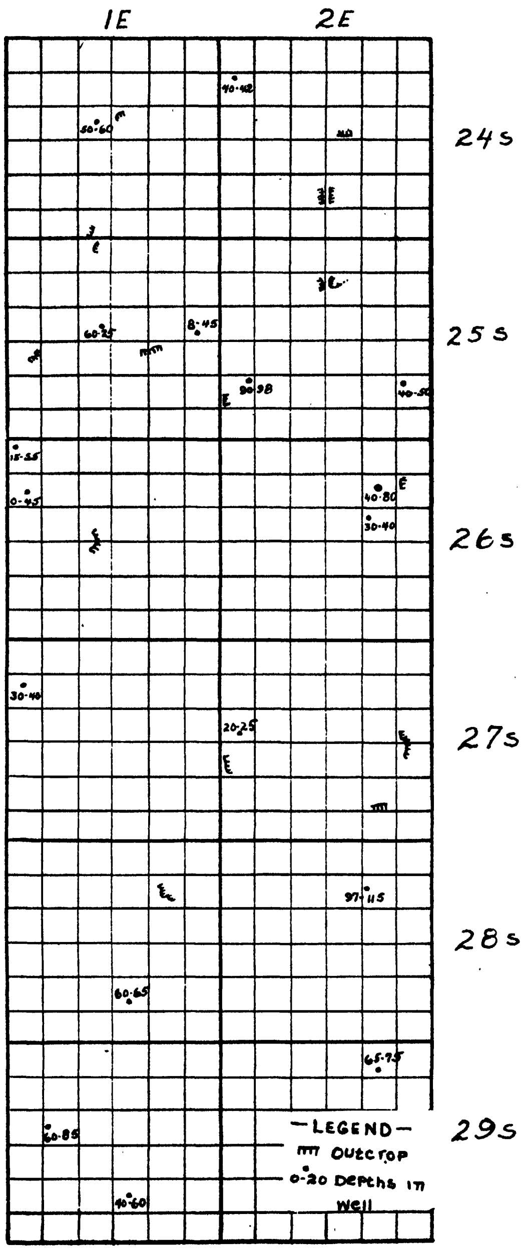
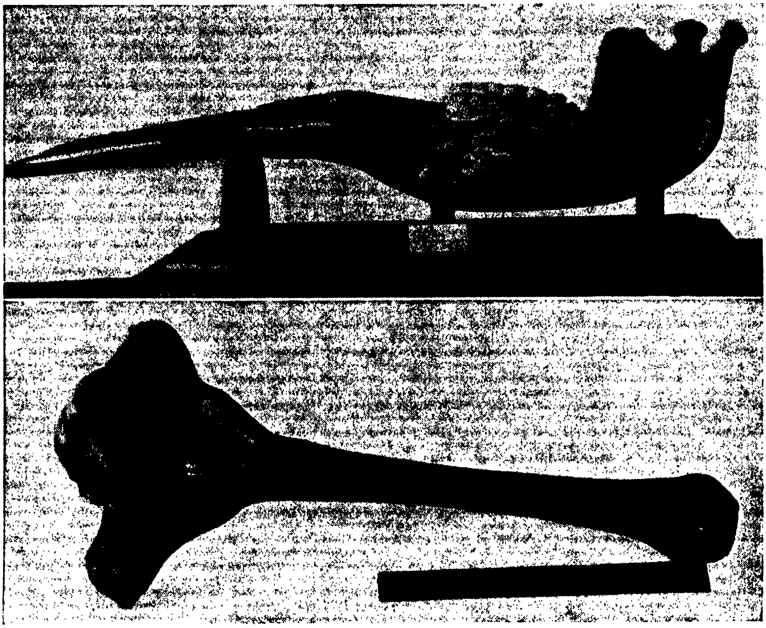


FIG. 1. Map of a portion of east Sedgwick county, showing the location of outcrops of terrace sands and the depths between which they are found in the wells indicated.

A New Amebelodon for Kansas

R. E. MOHLER, McPherson College, McPherson, Kan.

The subfamily of longirostrine mastodonts known as the Amebelodontinae is a comparative recent discovery. It is therefore a form not well known, and when referred to is generally spoken of as the shovel-tusk mastodon. The first one described was the work of Dr. E. H. Barbour, of the University of



AN AMEBELODON NEW TO KANSAS

The restored lower jaw and a vertebra at the museum of McPherson College. Discovered in April, 1935, by Mr. Richard Ganson, about five miles northwest of Canton, Kan. Excavated under the direction of Prof. R. E. Mohler. This work was in part financed by a grant from the American Association for the Advancement of Science made through the Kansas Academy of Science.

Nebraska, in 1927. Since that time a number have been described and quite a few individuals reported, but the number as yet is quite limited.

The specimen described in this paper was reported to the writer in April of 1936, by Mr. Richard Ganson, a farmer living near Canton, Kan. The specimen was partly uncovered by Mr. Ganson as he was attempting to find sand and gravel for concrete work about his farm buildings. The pit in which the specimen was found is one that has not been worked, because of the

fineness of the sand and the large amount of silt and clay it contained. It is located on the Ganson farm, four miles west and three miles north of Canton.

Work was at once started on uncovering and attempting to preserve the find. Due to the large size of the specimen and the extremely fragile condition of the fossil remains it was thought best to attempt to harden all materials slightly before placing in a cast and removing to the work room of the museum. This did not prove to be the best procedure, as vandals were able to get in their work in spite of every effort which, as might be expected, made many hours of extra work necessary before restoration was complete. Photographs and measurements were taken with every step of the work.

While one cannot be certain as to exact position and location of parts, such as angle between jaws, distance between condyles, etc., we feel that we have a restoration that is quite accurate. Proportions appear to be about correct, and a comparison with other restored specimens leads us to believe that our work is sufficiently accurate to be of genuine scientific worth. Imagination has been freely drawn upon in the restoration of the tusks.

The insertion of the tusks into the bones of the lower mandible is quite accurate. The position of the fragmentary anterior end of the mandible as related to the tusks was well established. A portion of a tusk fourteen inches in length was restored and the exact width and thickness determined. We have no way of knowing the length of these tusks and have estimated them as observed from other restored specimens.

The left half of the lower mandible as restored has been modified but little, as it was possible to secure the specimen in almost perfect condition and bring it to the museum, where adequate time was given to hardening and in every way preparing it for a permanent specimen. The right half was in equal state of preservation until disturbed by vandals. As it now stands it has been patterned quite largely from the left half.

In addition to the lower mandible described above, numerous small fragments of bones have been found in the pit. Four almost perfect vertebrae have been excavated and restored (two thoracic and two cervical). It has been reported that we have the only vertebrae that have as yet been found of the amebelodon. While it is possible that this report is not authentic, it indicates the scarcity of this form.

An idea of the exact size of this specimen is obtained by a comparison with the yardstick and ruler shown in the photographs. A more accurate idea is to be had from a study of the following measurements:

	Inches
Distance across condyles	21
Greatest width of jaw	20
Length of mandibles (estimated)	43
Width of mandibular tusk	6.5
Thickness of mandibular tusk	2
Total length of molar tooth	13
Width of molar	3.75
Diameter of thoracic vertebrae	5
Total width of thoracic vertebrae	12.5
Spinal process on thoracic vertebrae	19
Diameter of cervical vertebrae	5
Total width of cervical vertebrae	9

It is our intention to do additional work in this pit, but we are doubtful whether much more material will be found, as a number of cubic yards of material have been removed since any additional fossils have been uncovered.

Great thanks are due Mr. Ganson for his coöperation in helping to secure this valuable specimen. Not only has he been anxious to help in every way that he can, but every courtesy has been shown to those working the pit, and great effort has been extended to assist in preserving the materials found.

About thirty years ago there was brought to the museum of McPherson College an atlas bone that was thought to have come from an elephant. This bone was found in a ravine about a half mile below the pit where the present fossil was located. An attempt will be made to identify this as a possible part of the same specimen.

A survey of the available literature seems to indicate that this find is perhaps as closely related to the *Amebelodon fricki* described in Bulletin 15 of the Nebraska State Museum as any thus far described. There are many points of similarity between the two. The specimen here described appears to be larger than others previously reported.

A small contribution from the American Association for the Advancement of Science has assisted in making possible the restoration of this fine specimen. To them, to the Kansas Academy of Science, and to others who have assisted in any way, we owe our sincere appreciation and thanks. The Pleistocene gravels of McPherson county have proved quite fertile fields for many interesting fossils of the elephant, especially the Imperial and closely related forms, but in this case we believe we have the first Amebelodon found in this region.

Metamorphism in South Woodson County

(A Preliminary Paper)

D. C. SHAFFNER, College of Emporia, Emporia, Kan.

In the fall of 1937, while trying to find the Granite Ridge in Woodson county, the writer noticed several things of interest to a geologist. The first item was that while the location of the granite ridge was correctly depicted on our new state geology map as being in the east half of section 13 of T. 26, R. 15 E., and extending slightly into section 18 of R. 16 E., the location in regard to highway 75 is incorrect. As located on the map, the ridge is east of the highway, while in reality the exposed part of the ridge is west of the highway, just south of the point where the highway turns south on the township line, after following a diagonal southeast direction across parts of sections 11, 12 and 13. A glance at the chart will show how this came about. All of the highway maps that I have examined, as well as the survey map, show the diagonal beginning a mile too far south, thus throwing the line of the highway on the survey map on the wrong side of the ridge. This seems a small matter, but it caused the writer and a friend the loss of over a half day, because they tried to locate the ridge east of the highway and on section 13 of the correct township. After making inquiries and tramping several miles about the neighborhood, slightly metamorphosed limestones with numerous limonite nodules were found at three stations:

At A(1) along the road, south of the southwest quarter of section 13.

At A(2) near the middle of section 18, T. 26, R. 16 E. from the bottom of a gasoline pipe line ditch in the bottom of a ravine.

At A(3) at the east edge of the same section at the bottom of a well about 25 feet deep.

At B in section 19, T. 26, R. 16, in a stone quarry, the limestone has a decided dip to the southeast and the lower portion of the quarry face yields limestone that is indurated and may be called marble.

At N a sandstone ridge extending through parts of sections 29 and 20, about a mile southeast of the quarry, shows only slight cementation.

About seven miles, by country road, southwest of the low-lying granite ridge, is a prominent ridge, capped by Douglas sandstone. When approached from the east this ridge dominates the landscape. Some evidence of faulting was observed, but no careful measurements were made. However, the chief interest in this location, which includes parts of sections 28, 29, 32 and 33, T. 26, R. 15 E., centers around the extreme metamorphism which has effected a sheet of Douglas sandstone about 100 feet in thickness. As the road rises steeply just west of Buffalo creek, there is no evidence of metamorphism. However, about two thirds of the way up the ridge, pink, gray, green and black quartzites are indicated by D on the chart. The crest of the ridge marked E is a slightly hardened sandstone. At C, underlying the quartzites, extremely indurated shales are exposed in a ravine near the foot of the ridge. It was up the slopes of this ravine, just above the hardened shale and reaching nearly to the crest of the ridge, that the silver mining rush of the seventies occurred. The old prospect holes are still in evidence, where the miners sought shiny mica flakes, mistaking them for silver. On the south slope of the ridge, a short distance from the prospect holes which are quarried in the quartzite, a considerable exposure of yellow clay and mica flakes marks some prospecting activities, as indicated at H.

Trans. Kansas Acad. Science, Vol. 41, 1938.

The most interesting specimens collected on the ridge came from F, where a fine pure white vein of quartz has imbedded in it a few angular fragments of green quartzite. This cryptocrystalline quartz vein with the inclusions indicates a disturbance later than that which produced the quartzite.

While there is no observed induration of the surface rocks at the crest of the hills between the granite ridge and the quartzite ridge, the silicious magmatic waters that caused the extreme metamorphism of the Douglas sandstone of the ridge may have been freed at the time of the formation of the granite ridge. On the other hand, there may have been several intrusions of lava in the region, separated somewhat in time. More likely, the character of the mother liquor varied progressively. The striking difference of the magmatic additions to the limestone at A and D and the presence of the micaceous deposits at H all point to a variety of magmatic solutions liberated in the two areas. Furthermore, as noted the presence of the quartzite fragments in the quartz vein, clearly shows a later disturbance and invasion of magmatic water exclusively rich in quartz.

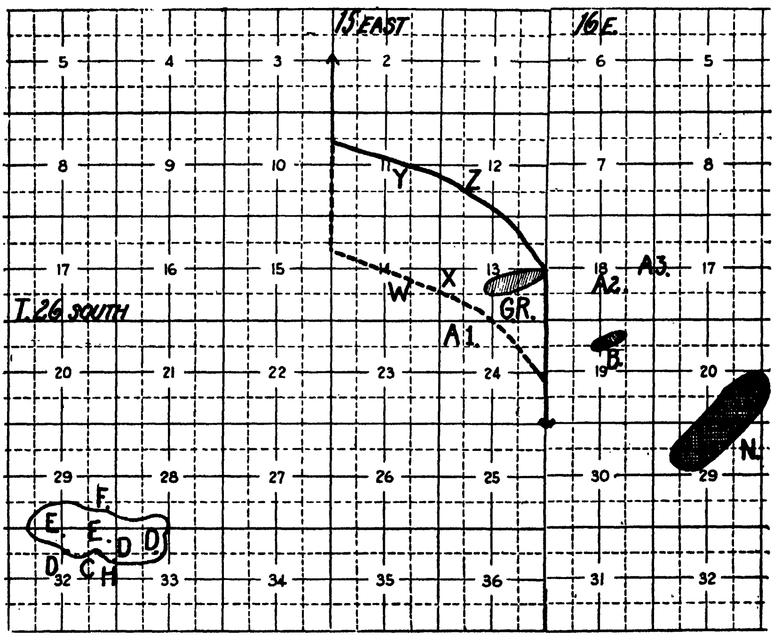


FIG. 1. Map of portion of township 26 S., ranges 15 E. and 16 E., in Woodson county, Kansas.

C. Metamorphosed shale.
D. Pink, green, gray and black quartzite.
F. Vein of granular white quartz with fragments of quartzite.
H. Mica deposit (the silver of the mining rush).
A(1), A(2), A(3). Indurated limestone with limonite nodules.
B. Indurated limestone, dipping S. E.
G. R. Granite ridge.
WX. U.S. 75 as shown on the geologic map of Kansas.
YZ. Correct position of U. S. highway 75.
N. Sandstone ridge.

Gastroliths in the Lower Dakota of Northern Kansas

D. C. SCHAFFNER, College of Emporia, Emporia, Kan.

At several places in northwestern Clay county, in one of the lower strata of fine-grained chocolate-brown Dakota sandstones, occur occasional finely polished pebbles of quartz of various colors—quartzite, chert, and sandstone ranging in size from one to three inches in diameter. The pebbles have been found most abundantly in the southeast portion of the southeast quarter of section 19, T. 7, R. 2 E., and immediately across the section line to the east in section 20, although numbers of good specimens have been found over 5 miles south and 2½ miles northwest of this locality. The distribution of these pebbles is haphazard. Usually they are found in the surface of the stratum. Neither the size nor the arrangement has any relation to the size of the adjacent particles. No lamination nor stratification marks indicate wave or current action.

As a high-school student, the writer collected these pebbles, noting their arrangement in the sandstone, and their distribution into adjacent downstream terrace and bar material. At that time the work of the ice along the Cretaceous sea was credited as the agent capable of effecting the exceptional polishing and distribution of these pebbles. After a more careful examination of the material in recent years, the ice theory of deposition has been abandoned as untenable, and the suggestion is ventured that these pebbles are gastroliths. Some of them are more or less pitted by wind- or water-borne sand after their loss from the dinosaur's gizzard and before or after they were imbedded in the sandstone. After gathering gastroliths from the Jurassic clay shales near Jensen, Utah, and comparing these authentic specimens with the Clay county material, the evidence points decisively to the conclusion that the Kansas pebbles are true gastroliths.

Pebbles polished by sand or dust blasts will show a uniform polish even in the sharp concavities, and the grain of the pebbles will show itself in ridges and depressions, the harder parts becoming prominent and the softer parts becoming depressed. Pebbles polished by water-borne sediments or current or wave action show chatter marks, and the abrasion causes the harder parts to stand out more prominently. Also the chatter marks result in a surface that does not compare in smoothness with dust polish.

The evidence may be summarized as follows:

1. The haphazard and widely separated occurrence of the pebbles, with no evidence of conglomerate structure in the sandstone stratum, excludes water as the depositing and polishing agent.

2. The remarkable variety of the pebbles themselves, and their occurrence without regard to size or weight in fine-grained sandstone generally confined to the surface, demands the same conclusion.

3. The position of the fine polish on the convex, flat or slightly concave surfaces, and the entire absence of polish from pits and deep concavities, excludes both wind and water-borne particles as the polishing agent, as well as excluding wave and current action.

15—4992

4. The satin smoothness of the polished surfaces, the absence of unevenness of any kind on the surface, the absence of this polish from the deeper depressions, all find their explanation in the assumption that the polish on the pebbles was acquired in the gizzards of dinosaurs.

The West Atchison Glacial Section

W. H. SCHOEWE, University of Kansas, Lawrence, Kan.

ABSTRACT

Paralleling and to the south of U. S. highway 59, extending for two miles west of Atchison, is a series of excellent exposures of glacial deposits. The outcrops occur in the steep south valley walls of Clay creek, in sections 3, 10 and 11, T. 6 S., R. 20 E. In the westernmost exposures two distinct tills are present. The lower till is a typical unaltered or fresh, dark gray to blue, compact boulder clay, as much as 20 feet thick. Its upper surface is irregular. The upper till, from 10 to 15 feet thick, is separated from the lower one by 50 feet or more of stratified sand. This till, in contrast to the lower one, is brown in color, and is very stony. The intervening sand in the easternmost outcrop is white, laminated, finely cross-bedded, and for the most part, of very fine texture. The sand is coarser, thicker bedded, cross-bedded on a larger scale, and less uniformly colored in the outcrops farther to the west. At some places considerable charcoal or carbonized wood inclusions are present in the sand. Also incorporated in the sand, especially in the westernmost exposures, are large masses of the lower blue till.

In 1918 Todd described similar deposits of stratified sands overlain by a till occuring in the vicinity of Atchison. Todd's report, however, contains no description of the west Atchison section here described. If Todd saw the deposits then he overlooked the first or lower one of the two till sheets. The writer is in general agreement with Todd that the sand represents a lacustrine deposit which was overridden by the advancing Kansan ice sheet. The presence of two tills, however, necessitates a modification of Todd's interpretation. It is clear that before the lake was formed an earlier ice sheet had advanced over the region. Whether this first drift sheet is to be correlated with the Nebraskan glacier, or whether it represents the first of two advances of the Kansan ice sheet, must remain unsettled until further studies are made.

Trans. Kansas Acad. Science, Vol. 41, 1938.

Celestite in Brown County, Kansas

WALTER H. SCHOEWE, University of Kansas, Lawrence, Kan.

ABSTRACT

The celestite deposits of northwestern Brown county, Kansas, have not hitherto been described. Previous to 1932 the celestite was known to occur at only one locality. In 1932 the writer discovered a second outcrop, and in 1934 a third deposit was located. All of the celestite is found just below the Americus limestone in the Hamlin shale of Permian age. The celestite is pale to deep pink, opaque to translucent, and occurs as: (1) large crystalline aggregates; (2) tightly compacted veins; and (3) disseminated particles. The aggregates consist of unoriented orthorhombic crystals, some of which measure 4 by ⅞ by 3/16 inches. The only well-defined crystal faces are macro-pinacoids and prisms. The crystals terminate commonly in basal pinacoidal cleavage surfaces. The clusters measure as much as 21.5 by 9.5 by 4 inches. The veins are discontinuous and vary in width from a mere trace to six inches. Some are vertical, and trend usually north and south; others trend east-west and are horizontal. Small crystal fragments or particles disseminated in the shale are closely associated with the veins.

These deposits differ from most other known occurrences in the United States in that the celestite is found in a shale; at most other localities it is either disseminated in limestone or dolomite or is contained in concretions and in the cavities of dominantly calcareous rocks. The celestite is epigenetic in origin and was formed by precipitation of strontium sulfate from circulating underground water.

Some Mineralogical Analyses of Eastern Kansas Sandstones

R. E. WHITLA, University of Kansas, Lawrence, Kan.

ABSTRACT

One of the problems associated with the sandstones of eastern Kansas is their mineral composition and distribution. Preliminary investigations were made of samples taken from the Tonganoxie sandstone, a sandstone layer in the Lane shale, the Cottage Grove sandstone, and a sandstone occurring at the base of the Missouri series which is correlated with the Warrensburg sandstone of Missouri. The heavy minerals were separated from the samples by the use of bromoform and identified by means of optical properties. Quartz makes up from 96 to 98 percent of the grains in the various samples. Muscovite, the most abundant of the heavy minerals, makes up 50 percent of the heavy mineral crop in some samples. Tourmaline was found in all four sandstones. Garnet, on the other hand, was identified only in a sample of Tonganoxie sandstone taken from near the base of that formation at the Tonganoxie city well. A number of conodonts were found in the heavy mineral crop of the same sample. Biotite was also present in the lower portion of the Tonganoxie and in the Warrensburg sandstones. Chlorite occurs in the Tonganoxie sandstone near its base, and as a trace in the Lane shale and the Warrensburg sandstone. Zircon occurs in the Tonganoxie sandstone near the top of that formation, in the Lane shale, and in the Warrensburg sandstone. Pyrite and apatite were identified in a sample of Warrensburg sandstone which was cemented with calcium carbonate. Sufficient investigations have not yet been made from which to make conclusive statements as to the mineral composition of these sandstones or as to the distribution of the minerals within the sandstones. It is hoped, however, that further investigations may be made in the near future which will enable one to make definite conclusions.

Trans. Kansas Acad. Science, Vol. 41, 1938.

Milk as a Source of Riboflavin (Vitamin G)[1]

BERNICE L. KUNERTH and W. H. RIDDELL, Kansas State College, Manhattan, Kan.

The constituents of milk have always been of interest to the nutrition worker, and the variation of some of these, such as fat, protein, sugar, ash and certain of the vitamins, have been studied in considerable detail. Today milk is recognized as the most important source of vitamin G (riboflavin) in human dietaries, though little is known of the variations of this essential factor in milk.

A previous investigation reported from this laboratory (1) showed significant changes in the riboflavin content of milk produced in the first month of lactation. Results of biological assay indicated the presence of about 5 micrograms of riboflavin per gram of first-day colostrum, 3.5 micrograms per gram of fifth-day milk, and about 2.1 micrograms of flavin per gram of milk produced on the thirtieth day.

In connection with other studies it was possible to secure data for the riboflavin content of milk produced by groups of cows in the fourth, fifth, and sixth months of lactation. Milk samples representing twenty-four-hour composites were secured and pooled according to breed and lactation period. Riboflavin content of milk was measured biologically by the Bourquin-Sherman method (2). According to this procedure groups of rats comparable as to age, sex, weight, and litter, are fed a basal diet deficient in the vitamin until their body reserves are depleted as indicated by cessation in weight gains. They then receive a supplement of the food to be tested, and their growth response is the basis of estimate of the vitamin content.

The average riboflavin value of milk produced by 21 cows representing 3 breeds in approximately the fourth month of lactation was 2.3 micrograms per gram of milk. Milk produced by 12 cows of 3 breeds in about the fifth month was found to contain 1.9 micrograms, and milk of 4 cows in the sixth month of lactation contained 2.3 micrograms of riboflavin per gram of milk.

The variation in these riboflavin values is small and probably of little significance. As these values are similar to those reported at the close of the first month of lactation (1), there is apparently little change in the riboflavin content of milk after the first month which can be attributed to advance in stage of lactation. This appears to be true certainly for the major part of the lactation period when milk production is heaviest.

From an average of these four values, milk produced by the cows in the herd studied is estimated to contain about 2.1 micrograms of riboflavin per gram. A composite sample of milk from the whole herd (representing some 55 cows of the 4 major dairy breeds) was found to have 2.0 micrograms per gram (1), or 1,950 micrograms per quart.

Steibling (3), in a study of dietary records, has estimated that diets supplying at least the minimum daily requirements for calories, protein, calcium, phosphorus, and iron supply about 600 Bourquin-Sherman units of vitamin G

1. Contribution No. 79 Department of Home Economics, and Contribution No. 122 Department of Dairy Husbandry, Kansas Agricultural Experiment Station, Kansas State College, Manhattan, Kan.

per adult per day. This figure is frequently used for estimating the adequacy of adult human dietaries. On the basis, therefore, that a Bourquin-Sherman unit is equivalent to about 3.6 micrograms of flavin (4), a pint of this milk daily would furnish nearly half the tentative dietary standard.

REFERENCES

1. KRAMER, M. M. Inez Gardner, B. L. Kunerth, and W. H. Riddell. Vitamin G (Riboflavin) content of colostrum and milk of cows determined biologically. Jour. Agr. Research 56:233. 1938.
2. BOURQUIN, A., and H. C. SHERMAN. Quantitative determinations of vitamin G (B^2). Jour. Amer. Chem. Soc. 53:3501. 1931.
3. DANIEL, E. P., and HAZEL E. MUNSELL. Vitamin content of foods. U. S. D. A. Miscellaneous Publication No. 275. 1937.
4. Unpublished data.

Mapping of Electric Fields Into Curvilinear Squares

R. J. W. KOOPMAN, University of Kansas

This paper deals with the mapping of electrostatic fields and the problem of mapping equipotential lines and flow lines for current flowing through conductors of unequal width but of the same thickness. Moreover, the fields are conservative, and Laplace's equation holds throughout the region being mapped. They are furthermore assumed not to vary in the direction of the third dimension.

The methods employed can be used in mapping fields other than electric, for unless something is known regarding the physical nature of the problem, inspection of a field plot will not reveal whether the flow lines represent electric current flow, heat flow, water flow, or lines of force.

Figure 1 shows a plot in curvilinear squares of the electrostatic fields between two planes at the same potential which intersect at an angle of 120°. The method used is mathematical. It can be shown that any analytic function of z where $z = x + jy$ is a solution of Laplace's equation in two dimensions. In this case the function of z may be taken as

$$z^{3/2} = (x + jy)^{3/2} = U + jV$$

Where U is equal to the real terms of $(x + jy)^{3/2}$ and V is equal to the imaginary terms.

The expansion of $(x + jy)^{3/2}$ presents some difficulties, but as $x + jy$ can be represented as a plane vector it may be written as $x + jy = r\epsilon^{j\Theta}$ where $r = \sqrt{x^2 + y^2}$ and $\Theta = \arctan \frac{y}{x}$ radians. Therefore,

$$(x + jy)^{3/2} = r^{3/2}\,\epsilon^{j3/2\Theta} = r^{3/2}\cos\frac{3}{2}\Theta + jr^{3/2}\sin\frac{3}{2}\Theta = U + jV.$$

Assigning a series of constant values to V, the equations,

$$r^{3/2}\sin\frac{3}{2}\Theta = \text{constant}$$

are obtained from which can be plotted a series of curves which are the equipotenitals.

Doing the same for

$$r^{3/2}\cos\frac{3}{2}\Theta = \text{constant}$$

A family of curves for the lines of force is obtained. In figure 1, Θ is measured from the right-hand plane to the left, r is measured from the vertex, and the equation of the first equipotential is $r^{3/2}\sin\frac{3}{2}\Theta = 1$. The equation for the first line of force to the right of the vertex is $r^{3/2}\cos\frac{3}{2}\Theta = 1$. For the second equipotential and line of force $r^{3/2}\sin\frac{3}{2}\Theta = 2$; and $r^{3/2}\cos\frac{3}{2}\Theta = 2$,

Trans. Kansas Acad. Science, Vol. 41, 1938.

respectively. By always choosing the same constants for the two equations the field can be mapped into curvilinear squares.

While it is probably theoretically possible to mathematically map any field, the mathematics become more complex as the boundaries of the field become more complicated, so that this method is virtually excluded in many practical problems. In this case it becomes necessary to map the field by free-hand drawing of the lines of force and the equipotentials. In using this method it becomes highly desirable to plot the field into curvilinear squares, some of the properties of which will now be discussed.

If a curvilinear square is subdivided into smaller curvilinear squares, the resultant subdivisions take on the appearance of squares, becoming more nearly true squares as the process is extended. Since the eye is fairly accurate in the detection of squares, this property can be used in the examination of any section of a map in question; and since a field is correctly mapped if every section is a curvilinear square, this property is fundamentally important.

Figure 2A shows a curvilinear square traced from a mathematical field plot. At first glance it appears to be anything but a square; but upon subdivision as shown in figure 2B, it is evident that it can be divided into sections more nearly like true squares. Carrying the subdivision farther than shown in the figure, the "spear-head" section could be made as small as desired and all other divisions would approach true squares. Whenever an irregular figure can be so subdivided it is a curvilinear square.

It has been shown by Doctor Lehmann[1] that the lines joining the centers of opposite sides of curvilinear squares are approximately equal when there is little difference in curvature of the sides. In figures 3A and 3B the lines ab, cd, a'b', and c'd' join the centers of the opposite sides of the two curvilinear squares (obtained by tracing from mathematical plots). Lines ab and cd are exactly equal, while lines a'b' and c'd' are equal within 95 percent. This second important property makes the detection of curvilinear squares with a compass a simple matter. In case the accuracy of this method of detection is in doubt, a subdivision can be made and the method applied to the sections thus obtained where the percentage error will be decreased.

However, as was pointed out before, if there is a great difference in curvature of the sides the above method will not work. Figures 4A and 4B show curvilinear squares where this method cannot be applied and the method of successive subdivision must be used.

As an example of the free-hand method, it will be used to find the lines of current flow in a conductor having the outlines shown in figure 5. The following procedure is useful: First, the flow lines are estimated as accurately as possible, as shown in the figure; then between these lines curvilinear squares are constructed, making use of the two geometrical properties of curvilinear squares just discussed. From this a diagram such as shown in figure 5 is obtained at a first attempt, which is obviously incorrect, as the equipotentials are not continuous lines. As there are too many sections on the left and not enough on the right, it appears that the flow lines must all be shifted to the right. By adjusting and repeating the processes just described until all the lines are continuous, intersect at right angles, and all sections are curvilinear

1. Lehmann, Th. La Lumière électrique. 8:103. 1909.

squares, a plot which is correct is finally obtained. Figure 6 is the result of this process.

Some other properties of curvilinear squares are as follows:

1. The potential drop across each is the same.
2. Equal amounts of flux or current per unit depth pass through each square.
3. The resistance of each square in the same.
4. The stored energy per unit depth is the same for each square.

The above properties are useful in making calculations after a field has been plotted.

For instance, if it is desirable to find the resistance between the first and last equipotential in figure 6, assuming the resistance of each square unity, all the squares in series are added and divided by the number of parallel paths. The result is 10/4. If this is divided into the resistance calculated by considering the conductors in sections, making no allowance for current distribution, a ratio of 70 percent is obtained, showing the importance of actually plotting the field when resistance of unusual shapes is desired.

FIGURES 1 TO 6

(See page 236)

FIGURE 1 shows a plot of the electric field between two charged planes of the same potential intersecting at 120°. The lines obtained mathematically rule the area into sections which are curvilinear squares.

FIGURE 2A shows a curvilinear square which at first thought does not appear to be one, but figure 2B shows that as it is subdivided the divisions take on the appearance of true squares.

FIGURE 3A shows a curvilinear square in which the lines joining the mid points of the sides are equal; figure 3B is a curvilinear square in which these lines are approximately equal.

FIGURES 4A and 4B show curvilinear squares of odd shape.

FIGURE 5 shows a first attempt to plot the flow lines and equipotentials for current flowing in a conductor of changing dimensions which makes a right angle bend.

FIGURE 6 shows the completed field map which was started in figure 5.

FIGURES 1 TO 6

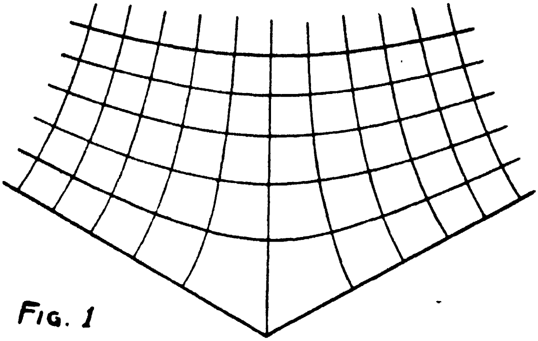


FIG. 1

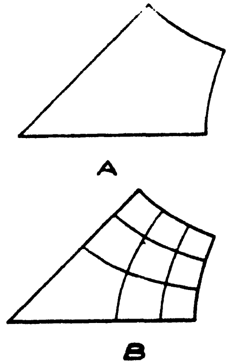


FIG. 2

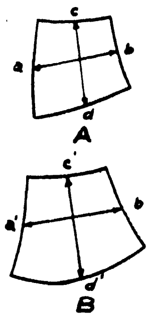


FIG. 3

FIG. 5

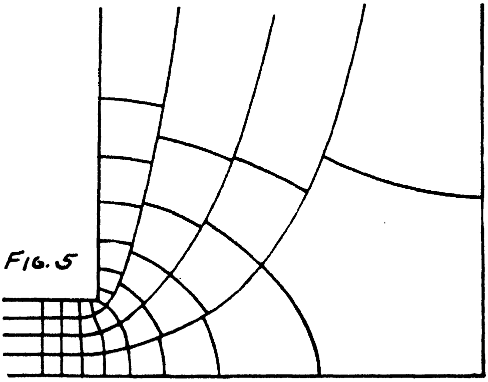
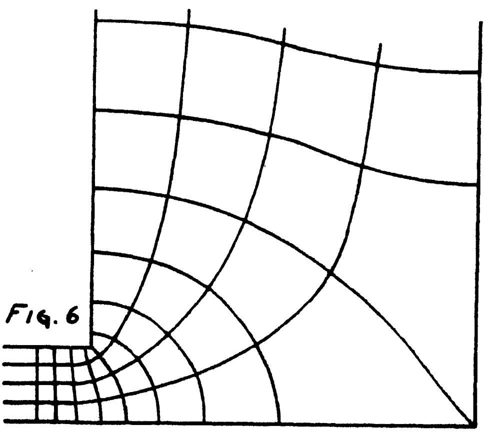


FIG. 6



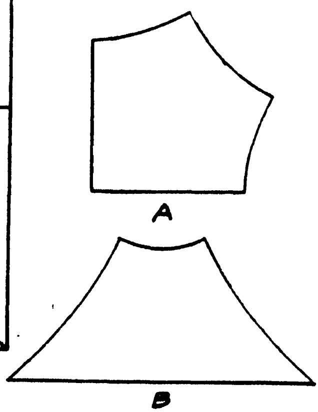


FIG 4

The Significance of the New Microcamera to Science Teachers and Students

LOUIS R. WEBER, Friends University, Wichita, Kan.

A common theory concerning the seeing of objects is based on the wave theory—that a disturbance in the wave causes us to detect the presence of the object. The diffraction theory tells us that each point of an object produces an image by means of an optical instrument, a system of concentric rings, bright and dark. If two points on the object are so close together that the innermost brightest ring of one image falls closer than the first innermost dark ring in the image of the second point, then we say the two points cannot be resolved, *i. e.*, they cannot be detected as separate points.

This criterion, first proposed by Lord Rayleigh, I believe, has been used by instrument makers and physicists and other scientific workers because experience substantiated the theory.

Doctors Graton and Dané, of Harvard, described a precision all-purpose microcamera in which they have resolved structure in minerals to from $\lambda/4$ to $\lambda/10$—four to ten times what the theory would predict. The lenses and mechanical structure are so well made that photographs made at intervals of focus equal to 1,000 angstrom units show changes in definition so that a layman can pick the best exposure without difficulty. "So long as the makers accepted the conventional limit as valid and had already attained it, there was little incentive toward progress. But with that limit apparently surpassed there is no present knowledge as to how far ahead the true limit may lie." [1]

They close their article with this plea, which, to me, is one of the most significant paragraphs ever written into a scientific paper that has come under my observation: "May we close with the plea that the lens makers, without waiting for a better theory—if one be needed—make effort to surpass their present best. If they can do better, we believe our instrument will recognize and record the improvement. We need the best high-power objective for vertical illumination that can be made. If advance from present quality of such a lens can be achieved, there should be many who would join us in securing them. But to test them and to obtain invariably the best results we believe they must be handled under more precise control of focus than has hitherto been available." [1]

Let us use theory and experimental results of others, but remember that they are a human product and affected by those who propose them. When we say physics or chemistry is an exact science, we infer that sociology or psychology is not. It might be better to say that in the natural sciences we have climbed a little higher towards the truth than the sociological sciences but if we could extrapolate ourselves into the far distant future, we would find all fields of phenomena to be equally exact.

Doctors Graton and Dané, with their microcamera, have realized that science is not static, since each new generation pushes a little closer to the

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Journal Optical Society of America, 27, 355, 1937.

truth. We should never use dogmatic statements concerning scientific phenomena, because that is only the way they appear to us.

Newtonian mechanics were sufficient for Newton's day and up to the discovery of the X rays. Now we know that bodies with velocities comparable to that of light need newer conceptions, due to Einstein, Lorentz, et al.

In Millikan's first work with cosmic rays, he detected no latitude effect. Now the *Physical Review* is full of papers showing there is a latitude effect. Finer instruments, more observations over wider territory by Millikan and Compton and others show this clearly. History has recorded too many incidents where scientists have scoffed at ideas proposed by others. These men have "missed the forest because of the trees."

So in your study of science, take this attitude toward everything you experience and the explanation of it: This phenomenon is the result of certain conditions or forces that have been brought together. Our present knowledge of it is based upon the perfection of man's experience in this field. The probability is that this experience will be continually added to. Maybe, *I* can add to it. It may be that this line of experience comes to a blind alley. We must begin again in an entirely different direction as we have done with the atomic theory.

But just as soon as one begins to call these phenomena "laws," he finds himself in the place of these lens makers—not progressing. For the true scientist, working with the Creator, can and has and will bring new forces together and create new conditions which to those who narrowly abide "by the laws" will ever seem "impossible."

Some New Lecture Demonstrations

LOUIS R. WEBER, Friends University, Wichita, Kan.

THE LOUD SPEAKER BAFFLE

As is well known, the loudspeaker of the small piston radiator type requires a baffle to prevent the radiation waves from the front and back sides of the vibrating diaphragm from neutralizing each other. Compressional waves formed in front of the cone actuated by the piston or voice coil must be prevented from flowing around the edge of the cone in time to destructively interfere with the corresponding rarefactions at the back. It is possible, therefore, for a baffle to increase the path difference between the compressional areas and rarefaction areas so that the relative phases are changed enough to practically prevent all neutralization.

Simple theory shows that this path length around the edge of the baffle is inversely proportional to the frequency and should equal $\lambda/4$ for the lowest frequency that one wishes to reproduce.

The model used by the writer to illustrate this principle is so simple that it may be used at present by many others, but it has never been described, to the author's knowledge.

A developing tray is filled half full of sand and held at an angle of about 30° to the horizontal plane. A pencil is held perpendicular to the tray and with one end projecting into the sand. Moving the pencil perpendicularly to its length through the sand rather slowly, the sand which is heaped up slightly ahead of the pencil (compressional wave) quickly fills in the vacant place (rarefaction) behind the pencil, leaving the total distribution of the sand undisturbed. By moving the pencil very rapidly a large percentage of sand can really be transferred from one end of the tray to the other before accumulated sand in front flows back.

This illustrates that for high frequencies the dimensions of the piston itself are sufficient for good radiation.

A portion of a shingle or other light material, if nearly the width of the tray, is now used instead of the pencil. Due to the longer time for the sand to flow around the edges of the board, the board may be moved quite slowly and still produce quite a change in the distribution of the sand.

Although the baffle does not move in actual practice as it does in the model, except in the Hewlett and electrostatic speaker, students very quickly see the point from this model.

DOUBLY REFRACTING MATERIAL BETWEEN CROSSED NICOLS

With the advent of new polarizing media on the market, demonstrations in polarized light before nontechnical as well as science groups are becoming more numerous. The textbooks are full of models showing both how polarizers and analyzers function, but only vector diagrams are used at present to explain how light may be passed through polarizer and analyzer when "crossed" by introducing between them a doubly refracting medium such as mica or strained specimens of glass.

The purpose of this model is to show in a very simple manner these vectors in a quasi-animated form.

A wooden frame, about 25 by 18 inches, is divided into three sections by

four horizontal, parallel strips. The bottom section holds one stretched horizontal wire upon which a wooden spool is free to move. The middle wire is stretched at a 45° angle between opposite corners of the middle section. A spool is also placed on this wire before securing the wire. A spool free to move on a vertical wire in the top section completes the main structure. The top and bottom spools are connected to the middle spool by rubber bands or strings. The frame is held in a vertical plane with its longest dimension vertical so that gravity keeps the top spools at their lowest positions. By moving the top spool up and down the vertical wire, we represent the plane polarized light produced by the polarizer. This light falling on the doubly refracting crystal (represented by the 45° angle wire in the middle section) excites a component of the initial vibration (through the rubber band), causing the middle spool to travel up the wire.

This vibration along the wire has a component in the horizontal plane which through the lower rubber band excites the lower spool into a horizontal motion representing the light transmitted in the analyzer. Thus, a vertical displacement of the top spool produces a horizontal motion in the bottom spool by means of an intermediate motion analagous to the plane polarized light of a polarizer. which excites a vibration in the analyzer at right angles by means of a doubly refracting medium placed between.

In this model we have ignored the component perpendicular to the wire, which in turn would produce interference with the component along the wire when their secondary components are considered in the analyzer.

THE GRAVITATIONAL FIELD

Students, as well as the average person, have difficulty in visualizing the motion of bodies in a central field of force such as the heavenly bodies about the sun.

These principles have been shown by projecting small steel balls near a strong magnetic pole. A much simpler device is to use an ordinary soup plate or glass funnel. A suitably sized marble is allowed to run down a small trough into the funnel near the top edge. The soup plate or funnel represents the central field and the component of the gravitational force towards the center is our central force.

If the ball travels at too high velocity we can depict the hyperbolic or parabolic path of a body such as a comet would describe. The ball remains in the field only a short time, since the centripetal force does not fulfill the conditions of $F = mv\frac{2}{1}r$. At smaller velocities the ball will be constrained to remain in an ellipitical orbit and the small friction allows the ball to make many circuits of the funnel before it comes to rest at the center of the funnel. Our earth, for instance, may end up in the same fashion, the friction and corresponding decrease in radius being imperceptible with our present instruments of measure.

Although the author first used the above model this fall, Doctor Sutton, of Haverford, demonstrated a similar model (but for illustrating another phenomena) at the Indianapolis meeting of the American Association of Physics Teachers. His purpose was to show the conversion of potential energy of the ball into kinetic energy of rotation. Thus, the ball completes the orbits in a very much shorter time as it descends into the funnel.

The Effect of Hydrostatic Pressure on Polarization in an Optical System

RICHARD H. ZINSZER, Indiana University, Bloomington, Ind.

The apparatus employed in this investigation was originally constructed for the purpose of determining the absorption of light for the region 6000 Å to 7000 Å when projected through an optical system and water at various pressures.[1] The assembly consisted of a Caillett pump of the Société Genevoise and a pressure chamber having glass windows at each end. The windows are mounted against a steel shoulder and have a layer of Canada Balsam between the steel surfaces. This seems to be the accepted method, since any packing produces unequal stresses in the glass, which later result in fractures. There are also two auxiliary chambers on the outside of the pressure windows which contain a solution of carbon bisulfide and carbon tetrachloride of the proper proportion to match[2] the index of the glass, thereby minimizing the errors of lens effects.

In the main study mentioned above, consideration was given to the possible existence of optical activity in the glass windows when subjected to pressure. A Babinet compensator and a pile of six plates of known index were used to make the trial run, the polarization being measured according to the conventional method.[3] The following equation is applicable in the evaluation of the data.

n = index of glass
i = angle of incidence
r = angle of refraction

$$\% \text{ polarization} = \frac{1 - \cos^{4n}(i-r)}{1 + \cos^{4n}(i-r)}$$

This test showed that at 240 kg/cm^2 there was 5.7 percent polarization in the transmitted beam. The result suggested that an extended investigation be given to observe the effect of pressure on the polarization of light by liquids under pressure.

Before this could be successfully attempted, it was necessary to be assured that no impurities were being dissolved in the distilled water within the pressure chamber, since Tornesite lacquer, a cholorinated rubber product, was being used to coat the inside of the steel chamber in order to inhibit corrosion.

In order to determine the presence of impurities in the compression fluid, a spectroscopic analysis was made of the water after having been under pressure at 1000 kg/cm^2 and in contact with the lacquer for several hours. A sample of the fluid was placed in a small discharge tube which was partially

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. R. H. Zinszer: Doctor's dissertation, Indiana University (1936); Phys. Rev., 50, 1097 (1936).
2. Review of Sci. Instruments 7, 156 (1936).
3. R. W. Wood: Physical Optics, 3d ed., p. 342 (1934).

evacuated, then this vapor was subjected to a high a.c. potential. The following table shows the results obtained from the spectroscopic analysis.

Substance	Time	Results
1. Mercury	10 sec.	Hg spectrum
2. Lacquer	35 min.	Two lines (4900 Å).
3. Air	15 min.	Band spectra
4. H_2O (impure)	30 min.	No lacquer lines, but band spectra.
5. H_2O (pure)	30 min.	Similar bands as No. 4.

The mercury and air spectra were used for the purpose of calibrating the spectrogram. In the excitation of the lacquer, two raies ultimes lines were photographed in the neighborhood of 4900 Angstroms. On comparing the impure and pure water spectra there was no difference in the character of the lines. We concluded, therefore, that whatever impurities were present were negligible.

The test on the optical activity of the glass windows immediately suggested that pressure might make a change in the rotation of the plane of polarization, due to sugar solutions. A polariscope was now constructed using a Lippich auxiliary prism, Hg arc, filter for the spectrum line 5461 Angstroms, large polarizing crystal and analyzer. (See fig. 1.)

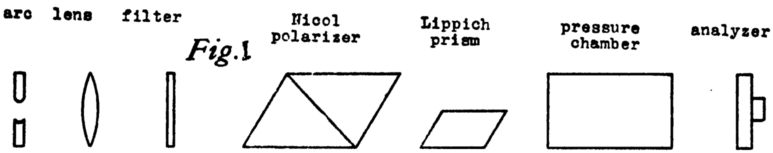


FIG. 1. Apparatus for determining polarization of liquids due to pressure.

To establish a basis of reference, distilled water was first used in a series of runs. The accompanying data in table I included pressures up to 500 kg/cm^2 and shows a rotation of two degrees. Since previous measurements indicated that an appreciable percentage of the transmitted light was polarized, this rotation can be attributed to the activity of the glass.

TABLE I.—Rotation of the plane of polarization, using water as the medium.

Degrees	Pressure
90.0	No water
90.0	50 kg/cm^2 (above atm. press.)
90.0	100 kg/cm^2 (above atm. press.)
90.0	150 kg/cm^2 (above atm. press.)
89.6	200 kg/cm^2 (above atm. press.)
89.4	310 kg/cm^2 (above atm. press.)
88.7	415 kg/cm^2 (above atm. press.)
88.0	500 kg/cm^2 (above atm. press.)

The following observations were next made with a solution of cane sugar, having a concentration of 15 gm/100cc and showing a decrease in the rotation with an increase in pressure.

TABLE II.—Rotation of the plane of polarization, using a sugar solution.

Temp. 20° C. $\lambda = 5461$.

Degrees	Pressure
74.5	No liquid
50	1 atm.
60	70 kg/cm² (above atm. press.)
66	120 kg/cm² (above atm. press.)
71	210 kg/cm² (above atm. press.)
72	350 kg/cm² (above atm. press.)
74.5	470 kg/cm² (above atm. press.)
74.6	585 kg/cm² (above atm. press.)

After this test the solution was held at two hundred atmospheres for several hours, upon which a second test was made, using the same solution.

TABLE III.—Rotation of the plane of polarization after pressure treatment.

Degrees	Pressure
71.2	1 atm.
72.2	160 kg/cm² (above atm. press.)
73.3	190 kg/cm² (above atm. press.)
77.0	300 kg/cm² (above atm. press.)
79.0	420 kg/cm² (above atm. press.)
79.7	500 kg/cm² (above atm. press.)
82.0	610 kg/cm² (above atm. press.)
83.5	690 kg/cm² (above atm. press.)

In the latter case there was a definite decrease in the amount of the rotation which might be explained by the sugar becoming inverted as a result of the pressure. This idea seems to be borne out by comparing the above data with table II, which shows the setting of 74.5° without the suggar solution in the chamber, and a setting of 50 degrees due to rotation when the sugar solution was added. As the pressure was increased the amount of rotation decreased. The following calculations showed that a theoretical rotation[4] of 55.8° should have taken place under atm. pressure. The experimental value is 55.5°:

CANE SUGAR

Temp. 20° C. Spec. Rotation = 66.5°

$$(\alpha)_t = 66.5 = \frac{av}{lg}$$

v = volume (100cc.)
a = optical rotation
l = length (4.8 dm.)
g = mass of sugar (15 gm.)
$\lambda_1 = 5890 \times 10^{-8}$ cm.
$\lambda_2 = 5461 \times 10^{-8}$ cm.

$$a = \frac{66.5 \times 4.8 \times 15}{100} = 48°.$$

$$a_{5890} = \frac{A}{\lambda_1} = 48° = \frac{A}{(5890 \times 10^{-8})^2}$$

$$A = 16.62 \times 10^{-8} \text{ (deg)}.$$

Conversion equation to ($\lambda = 5461$):

$$a_{5461} = \frac{A}{\lambda_2} = \frac{16.62 \times 10^{-8} \text{ (deg)}}{(5461 \times 10^{-8})^2} = 55.8°$$

4. C. R. Mann: "Manual of Adv. Optics," pp. 130-139 (1902).

To demonstrate the inversion of the sugar some of the solution was forced through a small orifice under a very high pressure. This ejected solution was allowed to evaporate and the formation of sugar crystals was expected; instead, a jelly substance formed. This phenomenon can be duplicated by a temperature change. It would be interesting to observe the effects of such a severe mechanical disruption on a colloidal system, and it is expected that a similar phenomenon might be produced by raising the temperature. Figure 2 presents the results in graphic form.

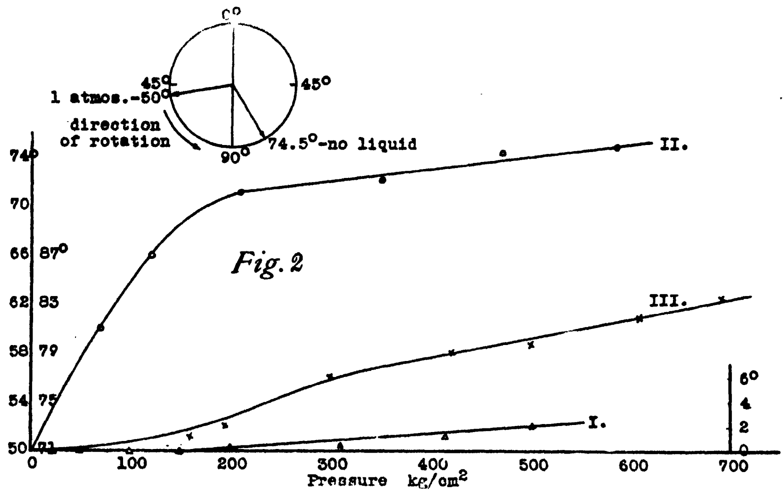


FIG. 2. Optical rotation as a function of pressure.

I. Water.

II. Sugar Solution 15 gm/100 cc. (first run).

III. Second run with solution of II after pressure treatment of 200 kg/cm^2 for several hours.

This research was carried on under the direction of the late Dr. John B. Dutcher, professor of optics at Indiana University, to whom much appreciation is due for suggesting the problem and for many kindly criticisms during the course of the investigation. This particular part of the investigation was made possible by a grant from the A. A. A. S., through the Kansas Academy of Science, for which the author is truly grateful.

Maladjustment to Responsibility

ROBERT L. BRIGDEN, Wichita Child Research Laboratory, Wichita, Kan.

The emphasis in clinical psychology is usually placed on the individual as a unique problem, the product of a particular group of factors. It is therefore noteworthy and interesting to discover in one clinic, within a period of three years, twenty-eight children whose behavior problems and home environment are almost identical. All of the cases were adolescent boys who were badly maladjusted to responsibility.

This paper has three aims: to describe this fairly common type of behavior problem, to attempt to explain it, and to outline remedial treatment.

The following descriptive facts, gathered from twenty-eight cases, are true of two thirds or more of the cases. The typical patient is a fairly healthy fourteen-year-old boy with an I. Q. of 105 or higher. His father is disinterested in him or away from home, thus inactive in the case. The mother, who contributes to the support of the family, is efficient and overdominating. She is the type who says, "Remember, mother knows best," or "My boy tells me everything he does and thinks about." There is a younger child of whom our patient is extremely jealous. He will tell you that he dislikes his brother because of the bad company he keeps.

The typical patient is referred to the laboratory by his school principal because of theft, truancy and, in spite of his high I. Q., school failure. The principal also informs us that the child is socially unsuccessful. He cheats in games, alibis, is called "sissy," and will do silly things to gain attention.

His performance on the Rorschach test approaches that of the typical depressed person. On the other hand, he is characteristically under high tension, though he seems to lack the stable organized power which gets work done. He is irresponsible, infantile, gives up easily, hates anything that looks like, or is called, work. He has a short attention span, feels hopelessly inferior to other children, is short-sighted, self-centered, unable to plan for himself, lacks motivation, is impulsive and feels that his desires of the present moment are so terribly important that they should be gratified regardless of future results or punishment. He seems to have no idea of the value of money and spends his week's allowance and lunch money the first day. He suffers from a lack of power and phantasies various forms of power or omnipotence for himself. He drove the family car like a speed maniac, and had hard luck so many times that the privilege was taken away from him.

So much for description. Let us now attempt to account for the behavior. Genetically, I believe that the situation is something like this: Since the father is shiftless, absent or inactive in caring for the boy, his mother doubly feels her responsibility to him, and, taking this responsibility too seriously, becomes overwatchful, over-solicitous and overhelpful. She is usually a very efficient person, and rather than see the child experiment, do things wrong, or venture out for himself, she does the things for him herself or else is everpresent to assist and correct. These boys are usually brought to the laboratory by their mothers, even though they are fourteen to sixteen years old. The children

respond to this parental care by becoming expert receivers—grownup babies—who depend on mother for everything.

In their social contacts they are failures, because they have never learned to give and take. Social success for early adolescents depends on self-confidence, originality, leadership, and superiority in athletics, mechanics, or special abilities. Our subject has none of these, and finds that his school-mates do not have the same attitude toward him that his mother does. He interprets this as rejection. His many problems that arise in adjusting to people distract him from school work, and his social failures make him withdraw from society. He has met social resistance and academic resistance. Because of his increased sensitivity to resistance he becomes aware, as never before, of his mother's overprotectiveness, which amounts to further resistance to his desires. It seems to him that she does not love him as much as she used to, and any favor she shows his sibling arouses his jealousy and completes his feeling of frustration.

Dynamically, the energy field of which he is a part is being contracted. Harsh teachers, mean children, a rival sibling and a worried mother are putting on more and more pressure. He is dismissed from school, prevented from driving the car, drops out of club because the children don't like him. He loses his orientation. He is no longer planning for the future; he is fighting for the right to do *as he wants to in the present.* In physics, we learn that power is a function of energy squared divided by resistance.

$$\text{Power} = \frac{E^2}{R}$$

In the case of our subject the resistance has increased, and due to lack of definite goals, his energy has decreased. The result is an actual loss of power. The patient feels this and attempts to gain power by theft, lies, buying people's loyalty, or doing silly things to gain attention at whatever cost. He may give up and run away from home. It won't do him any good, however, for his mother will go after him, bring him back and force him to remain in the frustrating home field. He will either attempt another escape, or become resigned to his fate and indulge his momentary whims.

If we consider our subject the victim of an abnormally contracted world, in which the only things that matter are the present and his desires of the moment, the remedial program will be built around the following steps:

First, give the subject insight into his condition and how he got there.

Second, reduce home pressure. Give the mother an understanding of what has happened and show her the need for reducing her domination. The boy is usually mentally advanced beyond his chronological age and his needs are explained to her in terms of the mental age. She is encouraged to treat the boy as though he were a man living at the house rather than her boy in long pants.

Third, increase his energy. In some cases this can be done medically by glandular or other therapy. In other cases energy is made available by assisting the subject to solve his problems and organize his efforts toward a definite future goal. Because of the age of the subject, a vocational goal is taken and the steps for reaching it worked out in detail with him. All of his interests, likes and dislikes are grouped into assets and liabilities in terms of

the main goal. This is worked out on paper and the paper given to the subject to take with him and peruse from time to time. He is encouraged to make all decisions in terms of his main goal.

Fourth, expand his field of interest. Scouts, Y. M. C. A., hobbies, church groups, some form of athletics, music, art, and especially a job, are valuable. Usually it is necessary to give advice on approved methods of getting along with people in order for these other efforts to succeed.

Fifth, if the father would be a desirable companion for the boy every means is used to convince him of the boy's need for him, not as a boss but as a pal. In other cases the coöperation of a father substitute is helpful.

Sixth, in our contacts with the subject we encourage him to take responsibility and to think of what he does in terms of its effects.

Seventh, in those cases where it is impossible to make the home a desirable place for the boy's reconstruction, an attempt is made to get him away from home—in the navy, C. C. C., boarding school, boarding home, and even at the county boys' detention farm.

While these plans sound easy on paper, actually we run into difficulties. The mother will not give up her domination, the boy will not be motivated, his attitudes toward people and his overevaluation of self make it difficult to expand his field. The boy may have deteriorated to such an extent that in just a few hours all of his enthusiasm which you have so carefully nurtured will dwindle, or perhaps during the reconstruction period he will get into trouble, so that new restriction must be applied. In two cases the boys refused to keep their appointments at the laboratory, so that treatment had to be discontinued.

Three factors which aid a favorable prognosis are: First, that the child is brought to your attention in the early stages of the difficulty; second, availability of a good job; third, a father who can come into the picture and become the boy's pal.

The Phenomenon of Mother Fixation as an Expression of the Child's Doubt of the Parent's Affection

EDWINA A. COWAN, Wichita Child-Research Laboratory, Wichita, Kan.

The phenomenon of mother-fixation, as it is discussed in the literature, is characterized by a type of behavior briefly described as "overdependent on the mother," and by a presumptive explanation in terms of overfondness on the part of the mother and a conscious or unconscious holding of the child to a close intimacy beyond the appropriate age of infancy. Because of the assumption that the extreme dependence on the part of the child is the result of the mother's indulgence of her own inordinate bonds of affection, therapy has consisted of attempts to persuade the mother to release the child, and of encouragement of the child both directly and indirectly toward self-reliance and adventures in independence. The breeding of excessive dependence by too much maternal devotion is a logical reconstruction of what might easily be imagined to have happened when one is confronted with the overdependent behavior manifestations common in the cases catalogued as mother-fixations. Some observed facts, however, do not check with this explanation of the behavior. For instance, some mothers have recognized overdependence in the child, have considered it as undersirable from its first appearance and have attempted to force the child into independence. Whereas this should have been helpful, according to the current theories of origin of the problem, the actual result was to increase the clinging of the child to the mother. In some cases the overdependent child has been from the beginning the child least favored by the mother. In other cases the behavior of the mother has seemed to run true to form and the child has been the recipient of much devoted time and service. However, there did not seem to be any uniform attitude or behavior on the part of mothers involved in these cases. The conclusion was forced on us that the overdependent attitude of the child was related to something other than an attitude or characteristic of the mother. Examining the personality traits and characteristics of the children, the same disturbing lack of a uniform factor was evident. The children who were exhibiting overdependent behavior toward the mother did not seem to show resemblance in any other single particular. Having failed to find a constant factor associated with overdependent behavior in either mothers or children, we were set looking elsewhere for it. A study of the life situations revealed that in each case there was something in the history or in the current situation of the child which had a potential capacity for creating a doubt in the mind of the child as to whether the mother really cared for the child. That is, the attitude of the child toward the mother did not seem to be characterized by a feeling of security in the mother as opposed to a feeling of apprehension directed toward the rest of the world. On the contrary, the attitude toward the mother herself was often colored and tinctured with fear, and a fear definitely connected with the mother. It is not easy for children to verbalize these feelings, but their fears seemed to be, not of, but about the mother. Looked at in the light of these considerations, the overdependent behavior took on a different

significance. It seemed not to be an expression of a close and affectionate bond which excluded the rest of the world because of its own strength. It rather represented a frantic effort at reassurance in the face of a consistent and disturbing doubt. The overdependent behavior itself seemed the expression of a constant effort on the part of the child to force the mother to allay the doubts of the child.

As one who fears he is not being a success endeavors to win from his companions reassuring expressions of admiration and respect, so these children, who, through some accident, have lost confidence in the security of their mother's affection, attempt by their own behavior to force the mothers to wait upon them, to hold them up, in order to demonstrate to themselves that their mothers actually are as devoted as the children wish them, but fear they may not be. In such a case the clinging of the child to the mother is not similar to a swimmer's gesture of holding to a safe, strong pier because he is unwilling to leave safety for adventure; it is more like the frantic clinging of the fingers used by one lost in deep water and holding to a slippery spar which constantly threatens to elude his clutching fingers. This has a definite significance for therapy. If one wished to loosen the fingers (the equivalent of diminishing the overdependent behavior) one would withdraw the pier in the first case, leaving the individual to experience safety without it, but in the second instance withdrawal of the spar would only increase the efforts to clutch it more tightly. In that case, in order to loosen the tension of the grasping hands, one would actually push the spar definitely into the hands, and, if possible, get it completely under the individual in order to permit him to experience safety without the desperate holding of hands. After this new approach was reached the problem of an overdependent child was dealt with in the following way: First, the factor was sought which was threatening the child's security in the mother's affection. Sometimes this threatening factor could be removed. Occasionally it consisted of a younger sibling or other member of the family who could not be casually expunged. In each case, however, the mother was advised to develop a program directed toward reassurance and the convincing of the child of the stability of the mother's affection for him. Eventually voluntary renunciation of overdependent actions by the child as a result of such a program encouraged us to believe we had correctly interpreted the behavior as expressing fear that the quality of the mother's affection had not been all that might be desired.

It is not to be assumed that overdependence is the only way in which a child may express this lack of confidence in the mother. Some children react with aggressive behavior against the mother, some with withdrawal, some with running away and some with a shift to the father or outside associates. The factor which determines what type of expression a child will use in meeting such a problem probably has nothing to do with the mother or the mother's attitude toward the child. Some factor in the child's own make-up probably determines his particular type of reaction in the face of this problem. The point we wish to make is that the problem to which the child is under necessity of adjusting is not an overdemanding or overfond nor even overcompensating attitude on the part of the mother, but an uncertainty on the part of the child which may have its source in something wholly dissociated with and apart from the mother. The following causes for loss of security in a mother's

affection have come under our observation. The most frequent is an accident which happens often to the first child in a family in the form of the birth of another child while the first child is still a baby. Second in frequency is the mother who works outside the home. The presence in the home of relatives, particularly the maternal grandmother, creates a situation in which the child faces a rival for the mother's attention who seems to have a primary advantage. A few cases of rejecting parents were discovered and a few cases in which the child's uncertainty had been created by intermittent periods of institutional life. In this category we must also include life situations which are so wholly and devastatingly insecure that the mother, as a part of that totality, takes on for the child the halo of instability surrounding the entire life picture. Marked physical incapacity on the part of the child creates such a situation. Death of the mother when the child is young and subsequent rejection by the father, broken families and transient families which move a great deal must also be mentioned. Certainly this does not exhaust the list of possible ways by which a child might lose security in his mother, but these are causes frequently met. May I give two concrete instances by way of illustration. A boy, who by the time he was 11 had lost his own father by divorce, had enjoyed the protection of a kindly and adequate stepfather for a period of months, had lost that father by sudden accidental death, had accompanied his mother in and out of mental hospitals and through the vagaries of her behavior, while she was becoming more and more unstable while living in her father's home, had finally seen her taken to a state mental hospital, and had then gone through a period of physical abuse and general mistreatment in the home of his natural father. At the time he came under observation he did not know whether his mother was alive or dead, whether she was actually in the insane asylum or had merely deserted him to go elsewhere and carry on her own life in happiness. He could not speak of her without tears. His every thought led back to her and he exhibited every sign of mother fixation. He was placed in correspondence with the supervisor of the hospital where his mother was an inmate. Although she was too ill to write him, the supervisor wrote of her condition, sent him a kodak picture of her and did everything in his power to make her situation concrete and actual for the child. The boy wrote letters to her regularly for about six months. He was encouraged to remember everything he could about her. Gradually there grew up in his mind a conviction of the sincerity of her maternal care for him while she was able to give it, and an understanding that her present lack of *rapport* with him was due to mental ill health for which she was in no way responsible. Being certain of her whereabouts, condition and the fact that she loved him as long as she was able to do so, he adjusted comfortably to her loss and gradually accepted her as a part of the background of his life, and began to show signs of increasing emotional maturity. The boy had developed an annoying habit of setting fires whenever he felt abused by anyone. After he was removed from his father's home and placed in a boarding home under social case work supervision, a program was instituted whereby he lit matches over a basin of water, dropping them into the water when they were burnt. This procedure was conducted daily, letting him light matches each day until he was tired of it and wanted to stop. After less than a year of boarding-home care he was returned to his father's home and to the

same abuse and mistreatment toward which he had previously responded with delinquent behavior, particularly arson. After some months he was unable to bear the home treatment further and ran away. This brought him again under the jurisdiction of the court, the home conditions became generally known, and a permanent boarding program was instituted for the child. During his last contact with the officers of the court he comported himself in a way that commanded the respect and liking of all who contacted him. During the entire period of his last incarceration in his father's home he was guilty of no delinquencies and set no fires. The reconditioning program to matches may have had its value in the handling of the arson symptom, but the general emotional maturity and improved social adjustment which the boy showed throughout this last period of stress and strain in his father's home must have been due in no small measure to the increased emotional stability which his adjustment to the problem of his mother had given him.

The second case was the case of a child whose parents were divorced and whose mother boarded her out until the child was about ten, when the mother was killed in the presence of the child under tragic and melodramatic circumstances. When seen a little later the child was in the grasp of a tremendously active mother-fixation. She would not permit her curls to be cut because her mother liked them. She would not consider going to an adoptive home because it would mean changing her name, and she wanted to keep her mother's name. She wanted to grow up to be a secretary because her mother had thought that would be a good thing for her to be. Apparently all her future life was to be devoted to the expression of a slavish devotion to a dead mother. The history showed that during the mother's lifetime she had paid very little attention to this child. After her death and when she could in no way contradict her, the child bent every thought to expressing filial devotion and an assumption of devotion on the part of the mother, against which the deceased had no come-back. The case workers who dealt with this child were never able to create enough belief in the child's mind in the sincerity of the mother's affection for her to overcome this mother fixation, and the child has always been, and is now, even in late adolescence, emotionally unstable and in a more or less precarious position as far as personality and emotional development is concerned. In the first case, success in reëstablishment of security in the mother's affection was followed by positive results in the shape of evanescence of the mother fixation. In the second case, failure of reëstablishment of security was associated with persistence of the fixation. This is in accord with our theories that behavior within the category of mother fixation is an expression of incomplete faith in the affection of the mother.

Insulin Shock Therapy in the Psychoses

RALPH J. DRAKE, M. D., Wichita, Kan.

The application of insulin shock for the psychoses developed as an outgrowth of Sakel's original employment of insulin in the treatment of the withdrawal symptoms in morphine addiction. In connection with this work, Sakel observed that the occasionally unavoidable hypoglycemic states which developed in these patients had an inhibitive effect on motor excitement. He then extended the application of this treatment to the schizophrenias and discovered that the hypoglycemic shock was beneficial in these mental states.

Since Sakel's work with the insulin shock in schizophrenia there have been a number of reports on the use of this form of treatment. The majority of the reports from Europe and this country reveal excellent results. Those from European clinics show that 75 percent of the patients ill less than a year are completely recovered and that more than 69 percent of those ill less than a year and a half are able to resume work. Spontaneous remissions without this form of therapy occur in from 10 to 15 percent.

Although psychoses of various types have been treated by this method, the best response has been in the schizophrenic group. This is especially true when the patient is seen in the early stages. As the onset is insidious, it is important to recognize the early symptons so that treatment may be instituted early. Among these initial symptoms may be mentioned a growing loss of social interest and indifference toward former interests. Undue suspiciousness may appear. There may be gradual failure in work, resulting partly from growing indifference toward it and partly from failure in concentration. There may be sudden unusual activity along religious lines or in the field of metaphysics.

Method of treatment. The treatment consists of a progressive insulization of the patient by daily intramuscular injection of increasing amounts of insulin until hypoglycemic shock is produced. The initial dose of insulin varies from 10 to 20 units, depending upon the physical status of the patient. This is increased by 5 to 10 units daily until shock dose is reached. The insulin is given at 7 a.m. on an empty stomach. The patient is kept in bed and from 4 to 5 hours later he receives from 150 to 200 grams of sugar by nasal tube. This is followed immediately by the regular midday meal. During the remainder of the day the patient is permitted to carry on the usual hospital routine. The hypoglycemic shocks are given daily except Sunday when all treatment is suspended.

Sakel recognizes four phases in the treatment:

Phase 1. In this phase the symptoms begin with a state of drowsiness followed by profuse sweating, lowered body temperature and, later on, increased flow of saliva, yawning and tremor of the extremities. Later, in this first phase, clonic twitchings of the muscles of the face and extremities may occur. At this point the patient may complain of intense hunger, a feeling

Trans. Kansas Acad. Science, Vol. 41, 1938.

of warmth over the body and slight numbness and tingling of the extremities and around the mouth. Itching of the nose is common. In this stage there is often a period of psychomotor excitement in which the patient may become violent.

Phase 2. This stage is the so-called shock-phase, which is characterized by the development of coma. The patient passes over gradually into superficial and deep coma. The normal reflexes become abolished and pathologic reflexes appear. Finally all reflexes disappear. Pallor, tachycardia, bradycardia, and changes in the blood pressure and respiration occur. At times the patient may assume the position of opisthotonus for as long as one hour or more. Generalized convulsions occur not infrequently in this phase. Transitory paralysis may develop.

A quiet coma with profuse perspiration is the best sign of a good response and generally means a good prognosis. Patients are allowed to remain in coma for an average of one to one and a half hours. It is wise to terminate the coma of excited patients while they are quiet, while in the depressed patient it is better to terminate coma when they are excited. As a rule there is an interval after each shock treatment in which the patient is free from his psychosis. This lasts about two to three hours and then there is a return to his former psychotic state.

Phase 3. This is the rest phase. After a series of shocks are given, an interval of one to several days is observed during which the patients receive little or no insulin—in any case no more than is absolutely necessary to the keep the patient quiet. If further treatment is found to be necessary the same procedure is repeated. If, however, satisfactory progress has apparently been made, the treatment is concluded by Phase 4.

Phase 4. This is the "Polarization" phase of Sakel. In this stage small doses of insulin are given three times daily to produce a state of prehypoglycemia. These doses are then gradually decreased.

The exact mechanism in this form of treatment is not yet known. However, it is probable that the mental improvement results largely from the change in the carbohydrate metabolism of the cells of the brain.

Dangers of treatment. The hypoglycemic shock should be terminated when certain dangerous symptoms arise. Cardiac collapse may occur in Phase 1 or Phase 2. The pulse becomes irregular and there may be tachycardia or bradycardia. Laryngeal spasm may develop. Epileptiform seizures and pulmonary edema are also signals for termination of the shock. Termination in such emergencies is carried out by the intravenous injection of 25 percent glucose solution.

CASE REPORT

A white girl, age twenty-four, was admitted to the hospital in a state of extreme mental confusion and excitement. On the day of admission she had thrown all of her personal belongings on the floor preparatory to packing for a trip to California to escape the people who were torturing her.

For the past three years she had had periods of elation and depression. Within the last six months she has felt that the women in the apartment house were talking about her—saying that she was a bad woman and unfit to take care of her child. People on the street also made slurring remarks about

her. She believed that her landlady was planning to have her murdered. The clinical diagnosis was schizophrenia.

Progress under treatment. This patient has received hypoglycemic shocks for a period of six weeks. There has been a gain of fifteen pounds in weight. Mentally there has been such improvement that she is entirely free from her ideas of reference and paranoid trend. Within one week from now she will be able to return to her duties at home and be able to take charge of her baby.

Summary. Insulin shock therapy is indicated in the treatment of the schizophrenias, as it appears to give the best hope for recovery in these cases. The mortality rate is less than one percent, and so with good clinical judgment in each case there is practically no danger to the patient.

An Evaluation of Beck's Rorschach Norms as Applied to Children

LEONE JACOBSON, Child Research Laboratory, Wichita, Kan.

For those of you who are unfamiliar with the Rorschach test, it consists of a set of ten cards, each of which contains a design made from an ink-blot. The subject is asked to report what he sees on the cards.

When we first started using Beck's norms in scoring the test we were immediately struck by the fact that the norms given seemed, for many of the items, too high for the children who are tested at the Wichita Child Research Laboratory. In bringing this to your attention we are not criticizing Beck's work, for he himself states definitely that "in respect to children, Rorschach's technique is still on much more insecure ground than in adults."

We are interested in the immediate use of the test and in modifying Beck's norms to the point where they are more helpful in aiding us in the diagnosis of children referred to the laboratory.

Since Beck does not tell us by what statistical procedures he arrived at the norms he suggests for use, it was impossible to use a comparable method. For the several items for which norms are available Beck divides his results into three groups, namely, high, medium, and low, and gives approximate numerical values for each of these three classifications.

The subjects used in this study were the first eighty children referred to the laboratory after we had used Beck's scoring method long enough to feel that we had adequately mastered it. Their mean age was 12, with a range of from 5 to 23 years. They were not a representative group of children in that, first of all and quite obviously, they were, if not problem children, at least unable to adjust to their environments; and, secondly, the intelligence of the group was lower than that of the average population: the mean IQ was 91, with a range of from 41 to 191.

Since we were first struck by the discrepancy between Beck's Z norms and our results, let us see if there was any statistical evidence for our belief. This Z score is the score for the ability to organize parts of the pictures into larger, more meaningful wholes. For our group the mean value of the Z response was 18, with a standard deviation of 2.65, making the range from 15 to 21 as compared to Beck's middle group, which was from 30 to 45. This great discrepancy led us to inquire whether or not there was any correlation between the score for organization, Z, and chronological age. Our results show some trend in this direction, with a product moment correlation of $+.31$, with a probable error of $\pm.07$. This is a significant correlation, and it is possible that with a larger and more normally selected group of children this relationship would be even more striking. We found, in addition, that the ability to organize material meaningfully is related in some measure to intelligence. The correlation coefficient for IQ with Z was $+.29$, with a probable error of $\pm.07$. The fact that our group was lower than the average in intelligence might be a possible reason why our Z scores were so far below Beck's. However, since

Trans. Kansas Acad. Science, Vol. 41, 1938.

17—4992

there is no reason to believe that the particular eighty children used in this study are strikingly different from the average that comes into the laboratory, the fact remains that in using this test with clinic children, it will probably be necessary to modify Beck's standards.

Using the same statistical methods, we found that Beck's standards were higher than ours for form perception, for percentage of animal responses (which is a measure of stereotypy), and for number of popular responses made.

Higher than Beck's scores were our scores for the S category (which is the tendency toward reversal of the field, toward reaction to the white background) and for the mean number of responses made.

In contrast to the discrepancy between Beck's norms and our results on the items mentioned, there was found to be comparative agreement between us in regard to scores for M (movement as a determinant of the response) and the scores for C (color as a determinant of the response).

It is interesting to note that in regard to Z, A%, and F+%, where our scores are lower than Beck's, there is a correlation between chronological age and the score in question, whereas in regard to M and C our scores are fairly comparable and there is no correlation between the scores and chronological age. This leads us to agree with Beck's statement that in dealing with children norms must be established for each chronological age level or for certain age ranges corresponding to recognized stages in personality development.

As an aid to diagnosis in a psychological clinic we are increasingly pleased with the Rorschach test and with Beck's method of scoring. However, as I have shown, we must modify some of his figures in order to make them pertinent and meaningful when dealing with the children that come into a psychological laboratory.

COMPARISON BETWEEN BECK'S* NORMS AND SCORES FOR 80 CHILDREN FROM WICHITA CHILD RESEARCH LABORATORY

	Beck's norms.			WCRL group.	
	High.	Medium.	Low.	Mean.	S. D.
Z	50 and up	30–45	25 and below	18	2.6
M	5 and up	2–4	1–0	3	3.6
C, sum	5	3	1	3	4.5
C, pure	2	1	0	1	3.6
F + %	85–100	65–85	60 and lower	65	17.5
A %	55–100	35–50	30–0	52	19
S	3	1–2	0	9	2.3
P	10	7–8	4 and below	4	2.3
R	35 and up	20–30	15 and below	30	16

* Samuel J. Beck, Introduction to the Rorschach Method. Published by the American Orthopsychiatric Association, 1937.

The Influence of Separate Answer Sheets on the Reliability and Norms of Standardized Achievement Tests

JAMES KUNTZ, Fort Hays Kansas State College, Hays Kan.

The Modern School Achievement Test, consisting of ten separate tests, and the Henmon-Nelson Test of Mental Ability, Grades 3-8, were administered to a group of students at a parochial school in Hays, Kan., to give some light on the problem of determining whether new norms should be established for use by the Testing Bureau of Fort Hays Kansas State College in handling survey test results and also to determine the reliability of these tests when separate answer sheets are used.

The tests included in the Modern School Achievement Test booklet are: reading comprehension, reading speed, arithmetic computation, arithmetic reasoning, spelling, health, language, history and civics, geography, and science. Forms A and B of the Henmon-Nelson Tests were given.

The students tested were in the sixth grade. The grade was divided into a north and a south room. The procedure was somewhat as follows: The north room was given the eleven tests, answers for which they recorded on separate answer sheets the first day, and in the test booklet in the normal way the second day. The south room was given the eleven tests with instructions to record their answers on the separate answer sheets both days. The purpose in proceeding in the manner described was to determine the amount of change made by using the separate answer sheets. The difference in test results for the two succeeding days which was obtained in the north room was due to practice and test form, while the difference found in the south room was due to practice effect alone. By canceling out the common element, practice effect, we have assumed that the difference between the results in the north room on the two succeeding days was due to the form of test used.

In order to determine the influence on the reliability of the test the individual scores made on the two successive administrations of the two tests in each room were correlated. Table I shows correlations between the two administrations in the two rooms. The correlations, as might be expected, are considerably higher when the same method of answering was used both days.

TABLE I.—Correlations between two administrations of Modern School Achievement Tests in each subject and Henmon-Nelson Test of Mental Ability, Grades 3-8

Subjects	*Answer sheets-Answer sheets*	*Answer sheets, normal*
Reading comprehension	.84	.69
Reading speed	.68	.80
Arithmetic computation	.65	.55
Arithmetic reasoning	.73	.68
Spelling	.63	.35
Health	.84	.76
Language	.41	.55
History and Civics	.70	.44
Geography	.72	.60
Science	.46	.26
Average	.84	.87
Henmon-Nelson, 3-8	.82	.81

Trans. Kansas Acad. Science, Vol. 41, 1938.

Relatively low correlations in spelling, language, and science can be noted, while high correlations exist between tests in reading comprehension, reading speed, health, and geography. Science was not included in the curriculum, and since most of the answers were made by guessing it is likely that an individual's position in the rank would be changed. Since the English language is not common in the homes of a large number of students attending this particular school the low correlation on the language tests might be explained as due to the interference of this language difficulty, which would, no doubt, result in guessing and some frustration on the part of the students. The spelling test was changed from a pronunciation test to a multiple choice form. According to the method now used, four words are presented in each test item, one of which is correctly spelled. Before the test booklets were revised for use with answer sheets the words were pronounced by the teacher and written in a blank in a sentence by the student. Many persons spell well when they have the opportunity to select a correctly spelled word from among incorrectly spelled words, as is done in the recognition or identification type of spelling test, but are unable to visualize a word sufficiently well to spell it orally or in writing, while others are confused by misspelled words. This type of difficulty would cause a low correlation between the two types of tests used.

The percent of improvement due to practice and form of test in the north room and due to practice in the south room was calculated and the difference between these improvements was found. These figures are shown in Table II. The positive differences are assumed to be due to form of test used or in favor of the normal test. The greatest differences are found in spelling, mental, health, and reading comprehension.

The negative difference in arithmetic reasoning which indicates that better performance was made on the answer sheets, is probably due to the suggesting of the correct answer. Four answers were given and the number of the correct one was to be encircled on the separate answer sheet. The reasoning problems had to be worked out on scratch paper in most instances, so the student was not slowed up in that respect. In the arithmetic computation test students were not permitted to make any marks or figures (carrying, etc.) on the test booklet. In many instances students copied the whole problem on scratch paper before attempting to solve it. A separate sheet of paper is used

TABLE II.—Comparison of improvement in two pairs of administrations: Answer sheet to normal and answer sheet to answer sheet.

Subject	*Percent improvement, Answer-Normal*	*Percent improvement, Answer-Answer*	*Diff.*
Reading comprehension	26.70	10.03	16.67
Reading speed	31.20	28.99	2.22
Arithmetic computation	12.48	3.23	9.25
Arithmetic reasoning	1.59	8.08	—6.49
Spelling	19.98	—.089	20.07
Health	32.51	13.96	18.55
Language	13.62	15.88	—2.26
History and civics	31.56	19.57	11.99
Geography	10.73	1.72	9.01
Science	8.29	—.43	8.72
Henmon-Nelson, 3-8	27.62	7.94	19.68

for writing answers. This sheet is placed underneath the problem, covering the four suggested answers, and then moved down when the answer to the problem is obtained. The obtained answer is then compared to the suggested

answers, and if it is found to correspond to one of the suggested answers it is recorded on the answer sheet by encircling the correct number. This method was demonstrated and followed by a large percentage of the students. So by using the test booklet the student should save considerable time and be much less confused.

In reading comprehension seven steps are required before the answer is recorded on the separate answer sheet. The student must first read the paragraph, note the blank to be filled, the line in which the word is found, the correct word for the blank, the number of the blank to be filled, the line on the check sheet, and finally the correct number in this line, which is encircled. It is easy to see why the difference is in favor of the test booklet on this test. When all these mechanics are required, it would seem that something besides achievement is being measured. The greatest difficulty is encountered in the lower grades, as will be shown later.

TABLE III.—Comparison of Modern School Achievement Test norms with western Kansas norms.

GRADE	4	5	6	7	8	*Avg.*
Subject	*Diff.*	*Diff.*	*Diff.*	*Diff.*	*Diff.*	*Diff.*
Reading comprehension	6	5	2	1	1	3.0
Reading speed	1	3	4	5	4	3.4
Arithmetic computation	0	1	1	2	0	.8
Arithmetic reasoning	—3	—2	—1	—1	—2	—1.8
Spelling	—8	—4	—2	—1	—2	—3.4
Health	5	5	4	3	3	4.0
Language	5	5	3	3	3	3.8
History	5	5	4	3	5	4.4
Geography	2	3	4	5	4	3.6
Science	0	2	2	2	2	1.6
Average Diff. of each grade	3.5	3.5	2.7	2.6	2.6	

The difference in reading speed is low, probably indicating that there is very little difference between use of the book and of the answer sheets. Instead of encircling the word in the book the number of the word is encircled on the answer sheet.

Since the differences were so great in favor of the test booklet, it was thought advisable to make new test norms for use in handling the survey test results in the testing office. New norms were made from scores of over twelve thousand children tested in western Kansas by the Testing Bureau. A comparison of these norms to the norms of the Modern School Achievement Test is shown in Table III.

The greatest difference is found in the fourth and fifth grades, probably indicating that ability to handle the mechanical aspects of the test is measured. All these differences favor the test book with two exceptions. These are arithmetic reasoning and spelling. The difference in favor of the answer sheets in arithmetic reasoning may be accounted for by the use of the selection type of test. The difference in favor of the book in spelling in Table II is probably due to the group tested and to learning of words after the first presentation.

Many of these differences are due to instructional and curricular differences in this section of the country and not due entirely to the change in the form of the test.

More extensive investigation is planned to determine more adequately the influence separate answer sheets have on this type of testing.

One Thousand Consecutive Cases of Speech Defects

MARTIN F. PALMER and COURTNEY D. OSBORN, Flo Brown Memorial Laboratory, University of Wichita, Wichita, Kan.

PURPOSE OF INVESTIGATION

This investigation was made to determine the relative incidence of various types of speech defects one may expect to meet in a distribution of 1,000 speech-defective individuals. It is realized that this distribution does not cover the total field of speech correction, since many less serious cases do not appear at a speech clinic, but the results should be indicative of the distribution of those cases serious enough to warrant attention from the speech clinic. No attempt is made in this paper to determine or discuss the etiology of speech defects.

METHOD OF INVESTIGATION

One thousand case histories were selected at random from the files of the Flo Brown Memorial Laboratory for Corrective Speech at the University of Wichita. This number was selected arbitrarily, since it was felt large enough to make a fairly reliable statistical result. These case histories were then examined to determine the type of defect, the age of the defective individual, the sex of the defective individual, and school information in children of grade-school age. These defects were grouped according to the general type of defect exhibited. Where a physiological or anatomical condition carries with it a characteristic form of speech, the speech defect was listed as that condition.

RELIABILITY

These case histories represent the examination records of individuals contacting the Flo Brown Memorial Laboratory for correction of their defects, and form the basis for training work at the laboratory. It is felt that these 1,000 cases offer a fairly accurate cross section of the speech defects found not only in public-school children, but also in individuals who never reach our public schools, individuals below school age, and individuals above school age.

GENERAL RESULTS

In the 1,000 cases examined there were 994 speech-defective individuals; 655 males and 339 females (3σ standard deviation $= 47.28$), possessing a total of 1,059 speech defects. The age groups ran from 16 months to 57 years.

Trans. Kansas Acad. Science, Vol. 41, 1938.

SPEECH-DEFECTIVE INDIVIDUALS CLASSIFIED

Speech Defects.	Male.	Female.	Total.
Articulation defects:			
Articulation	343	181	524
Retarded speech	5	4	9
Functional paralysis of the tongue	1	1	2
Hemiplegia of the tongue	1	0	1
Total simple articulation defects ($3\sigma = 34.74$)	350	186	536
Stuttering:			
Primary clonic stuttering 12			
Secondary clonic stuttering 17			
Primary tonic stuttering 15			
Secondary tonic stuttering 66			
Clonic-tonic stuttering 18			
Unclassified stuttering 96			
Total stuttering defects ($3\sigma = 22.44$)	170	54	224
Paralytics:			
Spastic paralysis, Little's disease [1]	47	35	82
Brain damage due to cerebrospinal meningitis	1	0	1
Paralysis due to poliomyelitis [1]	2	0	2
Paralysis as result of an accident	1	0	1
Auditory lesion	3	3	6
Paralysis of the tongue	1	1	2
Total paralytics	55	39	94
Defects characterized by nasal speech:			
Cleft palate	20	14	34
Cleft palate and hare lip	9	1	10
Congenitally short palate	2	3	5
Rhinolalia	12	5	17
Rhinolalia clausa	0	3	3
Total defects characterized by nasal speech	43	26	69
Endocrine defects with characteristic speech:			
Mongolism	18	7	25
Cretinism	2	3	5
Microcephalianism	3	1	4
Macrocephalianism	1	0	1
Acromegaly	2	0	2
Undetermined endocrine disorders	2	4	6
Total endocrine defects with characteristic speech	28	15	43
Deaf and hearing defects:			
Deaf	10	9	19
Hearing defects with characteristic speech [2]	7	2	9
Total deaf and hearing defects	17	11	28
Speechless not listed in other classifications	11	7	18
Defects of quality, pitch, and volume: [3]			
Hysterical aphonia	1	0	1
Aphonia	1	0	1
Partial aphonia from conditioning of ventricular folds	1	0	1
Low volume	0	1	1
Chronic inflammation of vocal folds	0	1	1
Chronic laryngitis	1	0	1
Singer's nodes	2	0	2
Pillars of fauces closed while talking	0	1	1
Monotone	0	1	1
Baryphonia	3	1	4
Partial baryphonia	0	1	1
Hutchinson's syndrome with characteristic speech	1	0	1
Total defects of quality, pitch, volume	10	6	16

1. Does not include simple articulation or stuttering defects with histories of birth injury or poliomyelitis.
2. Does not include articulation defects.
3. Not listed when accompanied by other speech disorder, such as stuttering or deafness.

SPEECH-DEFECTIVE INDIVIDUALS CLASSIFIED—CONCLUDED

SPEECH DEFECTS.	Male.	Female.	Total.
Aphasia and kindred defects:			
Syntactical aphasia	0	3	3
Aphasia	0	1	1
Echolalia	2	1	3
Logorrhea	1	0	1
Dyslogia	1	0	1
Total aphasia and kindred defects	4	5	9
Cluttering	7	0	7
Nervous disorders with characteristic speach:			
Choretic speech	1	0	1
Progressive epilepsy	2	1	3
Total nervous disorders with characteristic speech	3	1	4
All others:			
Brachycephalianism	1	1	2
Auditory memory span limited to one syllable	1	0	1
Hesitant speech with no spasms	1	0	1
Egocentric speech	2	0	2
Progressive loss of control of organs of speech	1	0	1
Benign tumor of the tongue	1	0	1
Accident to mouth	1	0	1
Difficulty in reading aloud	2	0	2
Total	10	1	11
Total defects found in 994 speech defective individuals	....	....	1,059
Total sex distribution of 1,059 speech defects	708	351	....

In the 1,000 cases there were six who were not speech problems:

True mental deficiency with no speech defect	2
Psychological problems with no speech defect	2
No speech problem	2

Fifty-two males and twelve females exhibited two or more separate distinct speech defects. The speech defects were:

Stuttering and articulation	45
Rhinolalia and articulation	6
Rhinolalia clausa and articulation	3
Spastic paralysis and mongolism	2

One each of the following:

Cluttering and articulation.
Dyslogia and articulation.
Logorrhea and cluttering.
Partial baryphonia and articulation.
Cleft palate, hare lip, and mongolism.
Brachycephalic and auditory lesion.
Speechless and cleft palate.
Articulation, stuttering and cluttering.

School information was gathered on 434 children above the age of 7 who were in grade school or of grade-school age:

In correct grade for age	134
Advanced one year	21
Total in correct grade for age or advanced	155

Retarded one grade for age	97
Retarded two grades	52
Retarded three grades	26
Retarded four grades	9
Retarded five grade	5
Retarded six grades	2
Retarded seven grades	2
In special rooms	13
Total in special rooms or retarded one to seven grades	206
Total children of grade-school age who had left school prior to examination,	3
Total children of grade-school age with speech defects too serious to permit them to enter school	70
Total children unable to attend school or retarded	279

CONCLUSION

The authors offer this material to the psychology section of the Academy for whatever interest and information it may afford. They call to your attention the fact that the generally accepted sex index for articulatory defects and stuttering is again confirmed in this paper.

Comparative Achievement in High School of Graduates From Graded and Ungraded Elementary Schools

H. B. REED, Fort Hays Kansas State College, Hays, Kan.

Slightly over half of the population in the high schools of Western Kansas comes from ungraded elementary schools. The problem of this paper is to find out whether children who enter the high school from ungraded elementary schools do as well in reading and in English as those who come from graded elementary schools.

To answer this question, achievement tests in reading and in English were given to 10 high schools. A total of 1,429 children were tested. Of this number 633 entered high school from graded elementary schools and 796 from ungraded elementary schools. Of those who entered from the graded elementary schools, 167 were freshmen, 146 were sophomores, 189 were juniors, and 131 were seniors. Of those who entered from ungraded elementary schools, 238 were freshmen, 211 were sophomores, 188 were juniors, and 159 were seniors. The tests given were the Nelson-Denny Reading Test, which consists of a vocabulary test and a paragraph reading test; the Nelson High-school English Test, which has separate tests for word usage, sentence structure, grammar, and punctuation; and the Henmon-Nelson Test of Mental Ability, grades 7 to 12.

In handling the data separate distributions were made of the graded and ungraded pupils in each grade. From these the following calculations were made: the median, the probable error, the difference between the medians, and the probable error of the difference. In order to make the scores in the separate tests comparable with each other, the raw scores were converted into McCall T-scores. The latter were calculated from total distributions of all of the high-school pupils in each test regardless of grade. In this scale 50 represents the average score in a test made by the total population. The calculations from the raw scores are given in Table I, while those for the McCall T-score are given in Table II.

If we look at the total results in Table I we find 36 pairs of comparisons between graded and ungraded pupils. Of these all but two show a difference in favor of the graded pupils. If we study the results by tests we find that in reading vocabulary there is a difference in favor of the graded pupils in every high-school grade except grade 11, but none of these differences are significant. In paragraph reading all the differences are in favor of the graded pupils, but the only differences that are significant are the ones in grades 9 and 10. In total reading all the differences are in favor of the graded pupils and all of them are significant. In word usage all the differences are in favor of the graded pupils and all of them are significant except the one in grade 12. In sentence structure all the differences are in favor of the graded pupils, but none are significant except the one in grade 10. In grammar all the differences are in favor of the graded pupils except the one in grade 11, but only the one in grade 9 is significant. In punctuation all the differences are in favor of the graded pupils and all of them are significant except the one in grade 10.

Trans. Kansas Acad. Science, Vol. 41, 1938.

In total English all of the differences are in favor of the graded pupils and all of them are significant. In the mental ability test all of the differences are in favor of the graded pupils, but only those in grades 11 and 12 are significant.

If we study the results by grades we find that there are significant differences in favor of the graded pupils in grade 9 in paragraph reading, total reading, word usage, grammar, punctuation, and total English. In grade 10 there are significant differences in favor of the graded pupils in paragraph reading, total reading, word usage, sentence structure, and total English. In grade 11 there are significant differences in favor of the graded pupils in total reading, word usage, and punctuation. In grade 12 there are significant differences in favor of the graded pupils only in total reading and total English.

The question which we have now to consider is whether the difference in intelligence is sufficient to account for the differences in achievement. This question is answered for us in Table II, which shows the differences between the tests in terms of McCall T-scores, which are thought to be comparable. In grade 9 the difference between the graded and ungraded pupils in the mental test is not equal to any differences in the achievement tests. In grade 10 the mental difference is large enough to account for the differences in reading vocabulary, paragraph reading, total reading, and punctuation, but not large enough to account for the differences in word usage, sentence structure, grammer, and total English. In grade 11 the mental difference is large enough to account for all the differences except the one in word usage. In grade 12 the mental difference is insufficient to account for the differences in word usage, sentence structure, punctuation, and total English. We thus see that the difference in mental ability between the graded and ungraded pupils is insufficient to account for any of the differences in grade 9. It accounts for four out of eight differences in achievement in grade 10, for seven out of eight differences in grade 11, and for four out of eight differences in grade 12.

The following inferences may be drawn from the results:

1. Since all but two of the tests show significant differences in favor of the graded pupils in grade 9, and since all the differences are larger than the difference in intelligence, the inferiority of the ungraded pupils must be due to inequalities in instruction. That is, the instruction in reading and English in the ungraded schools is not equal to that in the graded schools.

2. The differences between graded and ungraded pupils are reduced but not eliminated during the high-school period. Even in the senior year four out of the eight tests show significant differences in favor of the graded pupils, and these cannot be accounted for by differences in mental ability.

3. The instruction in reading and English in high school for pupils coming from the rural ungraded schools should be adjusted to meet their needs.

4. There is need of making the instruction in the rural schools more nearly equal to that existing in the town schools.

TABLE I.—Comparative achievement in the high school in Reading and English of graduates from graded elementary schools and from ungraded elementary schools. Raw scores.

Grade	9				10				11				12			
	Graded.	Ungraded.			Graded.	Ungraded.			Graded.	Ungraded.			Graded.	Ungraded.		
Number	167	238			146	211			189	188			131	159		
TEST.	Med.	Med.	Diff.	P.E. diff.	Med.	Med.	Diff.	P.E. diff.	Med.	Med.	Diff.	P.E. diff.	Med.	Med.	Diff.	P.E. diff.
Reading vocabulary	16.5	15.1	1.4	.71	21.66	18.9	2.76	.82	21.3	21.3	0.02	1.02	28.62	24.17	4.45	1.16
Paragraph reading	26.66	22.95	3.71	.72	31.55	27.1	4.45	.92	33.27	29.7	3.57	.96	36.6	33.71	2.89	1.17
Total reading	44.5	37.8	6.7	1.265	48.33	42.4	5.93	1.52	58.20	49.14	9.06	1.58	60.71	54.88	5.83	.68
Word usage	48.2	44.9	3.3	.74	51.8	47.9	3.9	.61	52.33	49.25	3.08	.55	52.43	50.47	1.96	.84
Sentence structure	35.34	33.8	1.54	.51	39.4	36.66	2.74	.56	39.10	37.58	1.52	.58	40.64	38.81	1.83	.61
Grammar	36.6	31.3	5.3	1.24	42.3	38.3	4.0	1.10	34.7	36.84	−2.14	1.14	41.57	40.37	1.20	1.07
Punctuation	24.57	18.53	6.04	.87	25.0	23.4	1.6	.76	29.03	25.34	3.69	.82	32.01	27.5	4.51	1.48
Total English	138.3	122.1	16.2	2.54	157.7	145.0	12.7	2.52	152.03	144.55	7.48	2.16	161.91	150.53	11.38	2.45
Mental	46.6	42.9	3.7	1.14	54.7	50.2	4.5	1.26	56.38	51.09	5.29	.98	60.68	56.20	4.48	.94

TABLE II.—Comparative achievement in the high school in Reading and English of graduates from graded elementary schools and from ungraded elementary schools. McCall T-scores

Grade	9			10			11			12		
	Graded.	Un-graded.		Graded.	Un-graded.		Graded.	Un-graded.		Graded.	Un-graded.	
Number	167	238		146	211		189	188		131	159	
Test.	Med.	Med.	Diff.	Med.	Med.	Diff.	Med.	Med.	Diff.	Med.	Med.	Diff.
Reading vocabulary	51.0	49.0	2.0	55.11	52.9	2.21	54.8	54.8	0.0	59.03	57.17	1.86
Paragraph reading	51.3	46.95	4.35	54.6	52.0	2.6	55.50	53.8	1.70	57.07	55.50	1.55
Total reading	49.8	45.87	3.93	51.30	49.0	2.30	55.30	51.10	4.20	56.28	54.0	2.28
Word usage	53.5	49.80	3.7	57.6	53.3	4.3	60.6	54.5	6.1	60.8	56.94	3.86
Sentence structure	52.6	49.6	3.0	58.8	54.66	4.14	58.2	55.58	2.62	61.28	57.60	3.68
Grammar	51.06	48.52	2.54	56.3	52.3	4.0	49.9	51.2	—1.3	55.57	54.37	1.20
Punctuation	53.14	46.33	6.61	54.0	51.4	2.60	57.0	54.20	2.80	60.0	55.6	4.4
Total English	50.09	44.8	5.29	56.7	52.0	4.7	54.8	51.8	3.0	57.7	54.2	3.5
Mental	47.3	45.45	1.85	53.7	50.2	3.5	54.90	50.6	4.30	58.04	55.2	2.84

A Technique for Selecting Students for Training in College Reading

V. T. SMITH, Kansas Wesleyan University, Salina, Kan.

It is now a fairly common practice for colleges to give training in study techniques to their students. In some schools this is done as a part of the orientation program, and in other schools it is offered as a separate course.

One of the most important phases of this kind of training is in the field of reading comprehension. Students who are found defective in reading comprehension are also discovered to be the ones who fail in college achievement. The correlation between reading comprehension ability and subject matter achievement is positive and fairly high. As a result of this fact it has been the plan in many schools to give reading training to all students whose reading comprehension scores are below a certain percentile rank.

Undoubtedly this is a useful procedure, as it has been found to improve to an appreciable degree the quality of work done by college students in general. However, when one realizes that the correlation between intelligence test scores and reading comprehension is exceedingly high, one is led to question whether it is worth while to attempt to train the student in reading ability who is low in general intelligence.

As a result of this line of thinking the question presented itself as to the desirability of giving reading training to all students whose reading achievement has not kept pace with the potentiality promised by their general intelligence. In order to discover the answer to this question, and as a basis for the selection of students to receive reading training, the following technique was used. The percentile rank in intelligence was subtracted from the percentile rank in reading achievement, and the control and experimental groups were paired on the basis of equal positive and negative differences. For example, every student in the control group with a positive difference of twenty between his percentile rank in intelligence and his percentile rank in reading was paired with a student in the experimental group whose difference was negative twenty. Every student with a score of six was paired with a student with a score of negative six, etc. These students were all grouped in the same class and given the same training in reading technique. The training consisted of ten lessons emphasizing getting the central thought, using the dictionary, underscoring, note taking, and the like. At the close of the ten weeks in which these lessons had been given at the rate of one each week, a second test in reading comprehension was administered to the entire group.

The positive group included ten students whose achievement in the first test had been particularly superior to their general intelligence, and the negative group included ten whose achievement had been much inferior to the promise of their general intelligence. On the average the percentile rank of the positive group in achievement was 14 percent higher than their percentile rank in intelligence, and on the average the achievement ranks of the negative group were 16 percent below the promise of their mental ability.

Trans. Kansas Acad. Science, Vol. 41, 1938.

The pupils who had negative scores, or, in other words, the students whose achievement in reading was not up to their intellectual capacity, made better improvements over their previous performance than did the group whose achievement was already better than their intelligence had promised.

When the first achievement test scores in reading for the positive group were subtracted from their second achievement test scores, the following differences were obtained: 8, —1, 3, 3, 1, —5, 1, 8, 1, 4. The average of this group is 2.3. When the first achievement test scores of the negative group were subtracted from their second achievement test scores, the following differences were obtained: 7, 8, 2, 10, —2, 5, 10, 4, 12, 8. The average of these differences is 6.4.

It is thus seen that although the two groups are both small, the differences between the achievement on the first and second tests are consistently greater for the members of the negative group. (Only two individuals exceeded the greatest gain in the other group.) This is to say that those students whose achievement was inferior to their intelligence when given achievement tests in reading profited almost three times as much on the average from training as did those whose achievement on that early test exceeded the promise of their intelligence.

It is interesting to note that this difference in improvement is not confined to any intelligence level. There is no observable difference in the amount of improvement between dull and bright students whose achievement was below what might be expected on the basis of their intelligence. The improvement among those who were already above their expected achievement ability was so little that a comparison between the bright and dull in that group was useless.

Although this study is definitely inadequate because of the limitation of numbers, it seems to point definitely to a useful technique in selecting students for training in reading. It appears probable that students cannot profit from reading training, regardless of their intellectual ability or disability, if their achievement in reading is already superior to the promise of their mentality. It is my conviction that using higher pressure in an endeavor to improve the reading comprehension ability of students who are low in such comprehension, but are higher than their potential ability in that field, would not only be a wasted endeavor but might result in producing an emotional distress on the part of the student. Also, it is my conviction that giving reading training only to the lowest 25 percent in reading achievement would not take care of those who are higher than that in reading achievement, but still lower than their mentality promises for them. This comparatively simple process of subtracting a student's intelligence percentile from his reading achievement percentile provides us with a useful technique for effective selection of college students for special reading training.

The Value of Psychological Diagnoses in a Community Program for Child Welfare

EDRA WEATHERS, Wichita Child Research Laboratory, Wichita, Kan.

The principal task of the Wichita Child Research Laboratory is to make psychological examinations of children and to report their findings and suggestions to the persons responsible for the child. The chief deficiency of this plan has been the fact that the laboratory has never had any satisfactory method of discovering what happened to the child; whether the program helped to solve his problem, left him worse than before, or was never tried. An examination of the laboratory records showed complete follow-up reports in less than five percent of the cases. The present research is an effort to find out what happened to the remaining ninety-five percent.

One of the chief problems encountered in this research is to establish a criterion of progress. When questioned, parents have a tendency to go to extremes—either the child is all right or he is no better. It seems impossible to establish a really objective measure. However, since the only criterion used by society seems to be that the individual is all right unless he is causing someone else worry or trouble, we shall probably have to be content with this criterion in the cases in which we are unable to have the child brought in for reëxamination. Our most objective results in the study thus far come from the sister nurses in the crippled children's ward of a local hospital, and these reports are most encouraging in their predominance of improvement in children's behavior when psychological programs are carried out.

The investigation has covered only some three hundred cases to date, but these few cases give some indications which may be significant of what can be expected. Most of the statistics presented here deal with the reports from parents and from a placement agency; since these two sources comprise about 85 percent of the cases investigated thus far.

In 76 percent of the total cases the suggested program was carried out. Of these, 87 percent showed improvement in the solution of the problem for which they were referred to the laboratory.

In considering the two groups separately we find that in 89 percent of the cases referred by parents, suggestions were carried out, and 92 percent of these children showed progress.

The placement agency carried out the suggested program in 70 percent of the cases, and 84 percent of the treated children showed improvement.

The reasons why psychological programs are not carried out vary greatly in these two groups. Fifty-five percent of the failures of the parents to carry out suggestions were due to the parents' objection to the diagnosis of the child's problem. In the agency group, failure to carry out the program was due, in 38 percent of the cases, to the fact that the children had been returned to their own families, in 17 percent to a lack of community facilities, in 12 percent to the transfer of the child to another agency, and in another 12 percent to inadequate casework.

Trans. Kansas Acad. Science, Vol. 41, 1938.

Among the children referred by parents we find the greatest amount of progress in birth injury training programs, speech programs, and school adjustment, while the smallest percentage of successes is in dealing with personality problems.

In the agency cases the greatest percentage of successes is in placement help, with personality adjustment techniques a close second. The smallest percentage of success is in dealing with cases of theft and incorrigible behavior.

In almost every case some sort of recommendation for physical examination was made. The most common recommendation was that the child be examined by an oculist. Investigation showed that parents carried out such recommendations in 69 percent of the cases, the agency in 78 percent of the cases. More unusual is the fact that parents carried out recommendations for glandular examinations in 92 percent of the cases; of these 74 percent needed therapy. The agency carried out requests for glandular examinations in 78 percent of the cases and 80 percent of these needed therapy.

Usually the agency's inability to carry out such recommendations is due either to a lack of funds or to the shifting of the child to his own parents or to another agency.

One of the most interesting factors discovered thus far in the study of the records of the placement agency is that in every case where the psychologists felt that the child was definitely superior, and the child was placed in a superior home, he kept up his superior development, while in the few cases in which the superior child was placed in an inferior home his efficiency lessened. These factors cannot be stated statistically, however, until the entire study is completed.

Other problems which might be mentioned are the impossibility of securing glandular examinations for Negro children, the difficulty in procuring extra tutoring for delinquents whose parents are indigent, and the percentage of cases referred by the schools in which it was impossible to carry out the program because of the lack of coöperation on the part of the parents. Yet often these problems are exactly the same for which parents have themselves referred children to the laboratory. It would seem, then, to be to the advantage of the school to persuade the parents themselves to refer the child for psychological diagnosis.

The best record to date comes from the crippled children's ward of a local hospital. In every case referred, recommendations were carried out, and in every case progress was noted in the solution of the problem for which the child was referred.

With so few cases investigated it is impossible to reach any definite conclusions. However, a few trends seem to be significant. Agencies are handicapped by lack of funds in getting reading and arithmetic training, and glandular examinations, and so their percentage of suggestions carried out in these fields is low. The agency, however, seems to be better equipped and to have more success in dealing with personality problems than do the parents. The parents, on the other hand, are far ahead of the agency in carrying out all training programs, speech, motor, reading and arithmetic.

When the research is finished we hope to have reports on about fifteen hundred cases from some ten different agencies. Until a greater percentage of the reports are in it is impossible to make any very definite statements.

The Report of the Committee[1] to Study Educational Trends in Secondary Schools of the State With Respect to Basic Sciences

O. W. ALM, Kansas State College, Manhattan, Kan.

Most of the data for this study were obtained from the high-school principals' reports for the school years of 1936-1937 and 1929-1930. These reports are on file in the office of the State Department of Education at Topeka. This source of data seemed more dependable and less expensive than the only other comparable source, a questionnaire to Kansas high schools.

The size of the committee, the funds, and the help available for this study required a sharp limitation of the investigation. To get significant data it seemed of first importance to select a fair, or large, sample of Kansas high schools. The reports for the school year 1936-1937 for 15 high schools in cities of the first class, 70 high schools in cities of the second class, and 148 high schools (approximately 25 percent of all such high schools) in cities of the third class were selected. Moreover, for comparison, data were likewise obtained from the reports of 1929-1930 for 70 high schools in cities of the second class. The Kansas Academy of Science allowed $25 to pay for the clerical help and materials necessary to obtain data. From a knowledge of the money available, the cost per hour for good clerical help, the results from tests of copying speed, and the number of schools selected, the number of different kinds of data that could be copied from each report was determined. The types of data that seemed to be of most immediate importance to the members of the Kansas Academy of Science were then selected.

Many very important phases of science education had to be omitted. No investigation was made of social sciences, home economics, vocational agriculture, mechanical courses and other courses in applied science, most of which could hardly be classified as basic sciences. One of the most regretted omissions was mathematics. It was also impossible with the help and means available, or impractical for other reasons, to investigate the methods of teaching, the content of science courses, the part science should play in the social scene, the relative importance of different sciences, and other phases and problems of science education. It was felt that the Academy was most interested in the facts about the status of science education in Kansas high schools. The study, moreover, was limited to the ninth, tenth, eleventh and twelfth grades in cities of the second and third class and largely to the tenth, eleventh and twelfth grades in the schools of cities of the first class.

RESULTS

The status of science education in the high schools is closely related to such general facts about enrollment as the number of pupils enrolled in the several grades, pupils graduating and graduates entering higher institutions. Without these facts it is difficult to determine definitely the extent of science education. They are presented in tables I and II.

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. O. W. Alm, Manhattan, Chairman; A. C. Carpenter, Ottawa; Miss Dale Zeller, Emporia.

Several facts of importance should be noted. The average high-school enrollment for each of the several grades in cities of the third class, as indicated in table I, constituted only a fair-size class. This means that in the interest of economy not many different courses in science or in other high-school subjects could be offered. If the percentages of students who graduated in 1936, which are presented in table II, are compared with similar percentages for enrollment in the ninth grade (see table I) it may be inferred that the pupils who graduated constituted a considerable proportion of those who enrolled as ninth-grade pupils in 1932. The percentages of graduates, moreover, were significantly higher for pupils enrolled in schools in cities of the second and third classes than in cities of the first class. This indicates that the elimination of pupils must have been much higher in cities of the first class than in cities of the second and third class. It should be noted, however, that the percentages of graduates who entered institutions of higher learning were clearly higher for schools in cities of the first class. Finally, it is especially significant that, in the main, less than 20 percent of the graduates in 1936 entered higher institutions. For the other 80 percent of the graduates the high school must have been the finishing school. A comparison of the data from schools in cities of the second class for the school years ending 1930 and 1937 indicate (1) some increase in general enrollment, (2) a considerable increase in the percentage of pupils graduating, and (3) a considerable decrease in the percentages of pupils entering higher institutions.

TABLE I.—The enrollment in Kansas high schools

Class of Cities, Nature of Data.	Ninth grade.	Tenth grade.	Eleventh grade.	Twelfth grade.
First class (1936-1937):				
Total enrollment	*8,052.7	7,189	5,415	4,120
Number of schools	15	15	15	15
Average enrollment per school	536.8	479.3	361	274.6
Percentage of enrollment in grades 10, 11, 12	....	43	32.5	24.6
Not reported	0	0	0	0
Second class (1936-1937):				
Total enrollment	8,041	7,206	6,235	5,295
Number of schools	69	69	69	69
Average enrollment per school	116.5	104.4	90.4	76.7
Percentages of total enrollment	30	26.9	23.3	19.8
Not reported	1	1	1	1
Third class (1936-1937):				
Total enrollment	3,587	3,145	2,724	2,356
Number of schools	144	145	144	144
Average enrollment per school	24.9	21.7	18.9	16.4
Percentages of total enrollment	30.4	26.5	23.1	20
Not reported	4	3	4	4
Second class (1929-1930):				
Total enrollment	6,747	6,187	5,226	4,453
Number of schools	67	69	69	69
Average enrollment per school	100.7	89.7	75.7	64.5
Percentages of total enrollment	30.5	27.1	22.9	19.5
Not reported	3	1	1	1

* This value was estimated by solving the ratio ninth-grade enrollment to tenth-grade enrollment for cities of the first class from the known ratio ninth-grade enrollment to tenth-grade enrollment for cities of the second class. This estimate seemed more comparable with ninth-grade enrollments for cities of the second and third class.

TABLE II.—The pupils graduating; and pupils graduating who also entered junior colleges, colleges, and universities

CLASS OF CITIES, NATURE OF DATA.	Students graduating.	Graduates who entered higher institutions of learning.	
		Girls.	Boys.
First class (1936-1937):			
Total number	3,945	804	937
Number of schools	15	15	15
Average per school	263	53.6	62.5
Percentages	(a) 16.4	(b) 20.2	(b) 23.5
Schools not reported	0	0	0
Second class (1936-1937):			
Total number	4,975	861	824
Number of schools	68	67	66
Average per school	73.2	12.9	12.5
Percentages	(c) 20.5	(b) 17.6	(b) 17.1
Schools not reported	2	3	4
Third class (1936-1937):			
Total number	2,305	291	289
Number of schools	145	112	115
Average per school	15.9	2.6	2.5
Percentages	(c) 19.5	(b) 16.4	(b) 15.7
Schools not reported	3	36	33
Second class (1929-1930):			
Total number	4,078	746	828
Number of schools	69	68	68
Average per school	59.1	11.0	12.2
Percentages	(a) 17.9	18.2	(b) 20.6
Schools not reported	1	2	2

(a). This value was obtained from 3,945 divided by 24,107. The total enrollment for 1935, 24,107, was estimated as follows: The ratio of the enrollment in grades 10, 11, and 12 for 1935 to the similar enrollment for 1936 was .973. When the enrollment of 24,776 for 1936 was multiplied by .973, the value obtained was 24,107.

(b). This value is the percentage of graduates who entered higher institutions.

(c). 19.5 was estimated as follows. The ratio of 1935 total enrollment to the 1936 enrollment was determined from values given by the 1935 and 1936 educational directories. This ratio was .995. Then the total average enrollment for 1935 was estimated by multiplying .995 by the total average enrollment for 1936. For cities of the third class the value was 19.5 which equals 15.9 divided by (.995 x 81.9). 20.5 was obtained by dividing 5,121.4, the estimated total of all graduates for spring, 1936, by the total enrollment of high schools for 1935-1936.

In this study it seemed that the ratios of the total enrollments in science to the total enrollment in high schools might be helpful. These data are presented in table III. The estimates entered under each class of cities are for schools not included in the main study. The estimates for schools in all third-class cities were obtained by multiplying the totals for 148 schools by four, since data were obtained for only 25 percent of the schools. The totals for general science and physical geography do not include the enrollments of schools in cities of the first class, since junior high schools in such cities were not included. The grand totals, the writer believes, are fairly reliable estimates of the total enrollments of public high school pupils for the several high-school science courses in September, 1936. The percentages of the total enrollments for all grades may seem very low. In fact, they are very low for botany and physical geography in general, and for chemistry, also, in cities of the third class. It is altogether possible that general science and biology courses are now covering much science material from botany, physical geography, and other sciences. It should be noted, moreover, that the sciences in-

TABLE III.—Estimated enrollments in different sciences in the ninth, tenth, eleventh, and twelfth grades of all Kansas high schools, September, 1936

Class of Cities, Nature of Data.	Agriculture.	Biology.	Botany.	Chemistry.	General science.	Physical geography.	Physics.	Physiology.	Psychology.
First Class:									
Totals	54	2,707	236	1,640	....	....	879	325	505
Number schools	1	14	3	13	....	....	14	6	8
Estimate for one school*	0	193	200	140	0	0	200	40	60
Totals	54	2,800	436	1,780	0	0	1,079	365	565
Second class:									
Totals	753	4,146	72	1,474	2,653	227	1,655	633	587
Number schools	25	62	2	41	50	8	28	23	60
Estimate for one school†	11	60	1	21	38	3	9	9	24
Totals	764	4,206	73	1,495	2,691	230	1,664	642	611
Six cities not included in main study	39	448	0	305	243	0	159	29	67
Totals	803	4,654	73	1,800	2,934	230	1,823	671	678
Third class:									
Totals	1,175	1,298	0	68	2,354	149	867	467	435
Number schools	75	77	0	5	112	9	36	37	77
Estimate for one school†	16	18	0	1	32	2	12	7	6
Totals for 148 schools	1,191	1,316	0	69	2,386	151	879	474	441
Estimates for all cities of the third class	4,764	5,264	0	276	9,544	604	3,512	1,896	1,764
Grand totals	5,621	12,718	509	3,856	12,478	834	6,414	2,932	3,007
Percentage of total enrollments for all grades‡	5.9	13.3	0.53	4.0	15.9	1.1	6.7	3.1	3.2

* A large school for which no data on enrollment for science courses was reported. Estimated on basis of data from Topeka high school.

† On the basis of averages for schools in cities of second and third class, respectively.

‡ With two exceptions, these percentages are the ratios of the grand totals for the several sciences to the estimated total enrollment in all high schools, 95,433. The two exceptions are general science and physical geography, for which the percentages were obtained by dividing by 78,706. The enrollment for schools in cities of the first class was omitted.

cluded in this study, excepting psychology, constitute only one of the nine different groups of studies that are offered in Kansas high schools. These groups are English, social science, sciences, languages, commerce, industrial and vocational subjects, music and art, and normal training. In addition, three units of English, two units of social science, and one unit of mathematics or laboratory science are required of all high school students. The ten units remaining for completing a high school education may be selected from any one or more of all the groups of studies excepting normal training.

On the basis of the data covered by this study, it is a safe estimate that there were in September, 1936, about 103,500 pupils enrolled in Kansas high schools. This includes an estimate for the ninth grade in cities of the first class. If the ninth grade in cities of the first class is excluded, there were approximately 95,400 high school pupils, and there were approximately 48,400 enrollments by these pupils in the basic sciences.

The average enrollment per school (for schools that reported classes) for schools in the different classes of cities and for the different sciences is given in table IV. The importance of these averages is largely a matter of net N, or the number of schools reporting. The percentages of schools that reported classes in the different sciences are also presented. It will be observed that very small percentages of schools held classes in botany and physical geography. The same was true for chemistry in cities of the third class. The percentages of schools in cities of the third class especially are too low because it is very probable that a considerable number of such schools in Kansas offer certain science courses only during alternate years. How many follow the practice was not determined. The high percentages of schools which held classes in biology, chemistry, general science, and physics in spite of these years of depression indicate the public's persistent faith in science education. Moreover, the differences between 1929 and 1936 in the percentages of schools which held classes in the different sciences has some significance; for in spite of the development of courses in applied science there is very little indication of any tendency to drop the basic science courses. Biology, chemistry, and general science all show significantly larger percentages of schools which offered these courses. Agriculture and physiology show considerably lower percentages for 1936, but the enrollments in vocational agriculture have greatly increased over 1929 and general agriculture, at any rate, must have been largely an applied and not a basic science.

The quartiles for the enrollment in the sciences as shown in table V indicate many small classes in cities of the third class. They mean that 25 percent of the schools had enrollments below the Q_1 values and 25 percent had enrollments above the Q_3 values. The smallest classes were in physics, physiology and psychology; but these were junior and senior year courses. It should be noted that the science courses were evidently considered sufficiently important to hold even small classes.

The location of the different science courses in the four grades is presented in table VI. The percentages of schools which offered each of the sciences in two or more years were considerable even in cities of the third class. Moreover, a comparison with the data for the school year 1929-1930 indicates a definite trend toward offering each of the science courses in two or more high school years. Obviously, this provided more opportunity to enroll for basic sciences.

TABLE IV.—The pupils enrolled in science courses in the high schools of Kansas, September, 1936

Class of Cities, Nature of Data.	Agri-culture.	Biology.	Botany.	Chem-istry.	General science.*	Physical geography.*	Physics.	Physi-ology.	Psy-chology.
First class:									
Total number of pupils	54	2,707	236	1,640	0	0	879	325	505
Net number†	1	14	3	13	0	0	14	5	8
Average for net number	54.0	193.4	78.7	126.2	0	0	62.9	65.0	63.1
Not reported‡	13	0	11	1	0	0	0	9	6
Percent of schools	7.1	100.0	21.3	92.9	0	0	100.0	35.7	57.1
Second class:									
Total number of pupils	753	4,146	72	1,474	2,653	227	1,655	633	587
Net number†	25	62	2	41	50	8	60	23	28
Average for net number	30.1	66.9	36.0	36.0	53.1	28.4	27.6	27.5	21.0
Not reported‡	44	7	67	28	19	61	9	46	41
Percent of schools	36.2	89.9	2.9	59.4	72.4	11.6	86.9	33.3	40.6
Third class:									
Total number of pupils	1,175	1,298	0	68	2,354	149	867	467	435
Net number†	75	77	0	5	112	9	77	37	36
Average for net number	15.6	16.9	0.0	13.6	21.0	16.6	11.3	12.6	12.1
Not reported‡	71	69	146	141	34	137	69	109	110
Percent of schools	51.4	52.7	0.0	3.8	78.3	6.2	53.1	26.2	26.5
	SEPTEMBER, 1929								
Second class:									
Total number	1,121	2,567	84	1,054	1,323	193	1,905	792	491
Net number†	42	53	3	32	39	10	63	34	27
Average for net number	26.7	50.1	28.0	32.9	33.9	19.3	30.2	23.3	18.2
Not reported‡	26	15	65	36	29	58	5	34	41
Percent of schools	62.0	77.9	4.4	47.1	57.4	14.7	92.6	50.0	39.7

* The ninth grade in cities of the first class was not included.

† The number of high schools with classes in each science.

‡ Number of schools not reporting any classes.

TABLE V.—Quartiles of the enrollment in science courses in September

Class of Cities, Nature of Data.	Agriculture.	Biology.	Botany.	Chemistry.	General science.	Physical geography.	Physics.	Physiology.	Psychology.
Second class, 1936-1937:									
Q1	27.0	31.4	0	18.8	32.5	20.0	15.8	17.1	12.0
Q3	35.3	78.4	0	59.4	65.4	34.0	32.7	34.0	29.4
Number schools	24	62	2	41	50	8	60	23	28
Schools not reported	46	8	68	29	20	62	10	47	42
Second class, 1929-1930:									
Q1	19.5	24.5	0	16.3	22.8	15.0	17.0	15.4	12.0
Q3	30.0	63.8	0	41.7	39.3	23.0	37.2	23.8	21.2
Number schools	42	53	3	32	39	10	63	34	28
Schools not reported	28	17	67	38	31	60	7	36	42
Third class, 1936-1937:									
Q1	10.3	11.8	0	0	14.0	0	7.7	7.8	8.0
Q3	20.1	21.5	0	0	24.2	0	15.1	18.4	17.0
Number schools	75	77	0	5	112	9	77	37	36
Schools not reported	73	71	148	143	36	139	71	111	112

TABLE VI.—Grade location of basic science courses in the nigh schools of Kansas*

Class of Cities, Nature of Data.	Agri-culture.	Biology.	Botany.	Chem-istry.	General science.	Physical geography.	Physics.	Physi-ology.	Psy-chology.
First class:									
Net number†	2	15	4	15	0	0	15	10	10
Percent in 9th grade‡	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0.0
Percent in 10th grade	50.0	80.0	50.0	0.0	0	0	0.0	30.0	0.0
Percent in 11th grade	100.0	60.0	100.0	73.3	0	0	53.3	60.0	60.0
Percent in 12th grade	50.0	13.3	25.0	53.3	0	0	86.6	60.0	80.0
Percent offering in two or more grades	50.0	33.3	75.0	26.6	0	0	46.6	33.3	50.0
Percent of schools†	13.4	100.0	26.7	100.0	0	0	100.0	66.7	66.7
Second class:									
Net number†	28	59	2	41	57	13	58	28	33
Percent in 9th grade‡	17.8	1.7	0.0	0.0	94.7	46.2	0.0	3.6	0.0
Percent in 10th grade	100.0	52.5	0.0	0.0	7.0	46.2	0.0	25.0	0.0
Percent in 11th grade	10.7	57.6	50.0	73.2	1.8	23.1	56.9	78.6	54.5
Percent in 12th grade	3.6	27.1	50.0	68.3	1.8	7.7	81.0	35.7	93.9
Percent offering in two or more grades	21.4	33.9	0.0	43.9	7.0	23.1	39.6	46.4	48.5
Percent of schools†	41.2	86.8	2.9	60.3	83.8	19.1	85.3	41.2	48.5
Third class:									
Net number†	74	73	0.0	7	112	23	76	60	75
Percent in 9th grade‡	27.0	0.0	0.0	14.3	100.0	47.8	0.0	1.7	0.0
Percent in 10th grade	93.2	15.1	0.0	0.0	25.0	47.8	1.3	13.3	4.0
Percent in 11th grade	16.2	80.8	0.0	85.7	0.9	52.2	56.6	81.7	48.0
Percent in 12th grade	2.7	49.3	0.0	57.1	0.0	13.0	90.8	48.3	84.0
Percent offering in two or more grades	30.8	38.7	0.0	57.1	22.9	34.6	44.5	29.6	32.5
Percent of schools†	54.7	54.1	0.0	4.7	82.4	17.6	54.7	45.3	54.1
	1929-1930								
Second class:									
Net number†	38	44	3	24	39	11	57	33	40
Percent in 9th grade‡	5.3	0.0	0.0	0.0	97.4	72.7	0.0	3.0	0.0
Percent in 10th grade	92.1	31.8	0.0	0.0	2.6	9.1	0.0	6.1	0.0
Percent in 11th grade	5.3	72.7	66.7	66.7	0.0	27.3	38.6	87.9	35.0
Percent in 12th grade	2.6	22.7	66.7	75.0	0.0	0.0	84.2	18.2	75.0
Percent offering in two or more grades	7.5	21.5	33.3	31.0	0.0	8.3	20.9	13.8	9.1
Percent of schools†	62.5	79.7	4.7	45.3	65.6	18.8	96.9	56.3	68.8

* A comparison between this table and table IV reveals some apparent discrepancies. In general the number of schools listing courses as offered is higher than the number of schools actually holding classes in these courses. This may be due to different causes such as failure of classes to fill, and the offering of some courses on alternate years.

† Net number in this case is the number of schools reporting definite grade locations for the different courses. But some schools have reported their offerings without grade locations. They were included in determining the percent of schools offering any science subject.

‡ Each of these percentages and of those following for grades ten, eleven, and twelve is the percentage of all schools offering courses in the particular science who offered it in the particular grade involved.

TABLE VII.—The teachers of courses in basic sciences

Class of Cities, Nature of Data.	Agriculture.	Biology.	Botany.	Chemistry.	General science.	Physical geography	Physics.	Physiology.	Psychology.
1936-1937									
First class:									
Number of teachers	1	28	4	17	0	0	17	6	9
Schools reporting classes	1	14	3	13	0	0	14	5	8
Averages	1.0	2.0	1.3	1.3	0	0	1.2	1.2	1.1
Number of pupils per teacher*	54.0	96.7	59.0	96.5	0	0	51.7	54.1	56.1
Second class:									
Number of teachers	29	77	2	41	55	10	60	27	29
Schools reporting classes	25	62	2	41	50	8	60	23	28
Averages	1.2	1.2	1.0	1.0	1.1	1.3	1.0	1.2	1.0
Number of pupils per teacher*	26.0	53.8	36.0	36.0	48.2	22.7	27.6	23.4	20.2
Third class:									
Number of teachers	75	77	0	5	112	9	77	37	36
Schools reporting classes	75	77	0	5	112	9	77	37	36
Averages	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
Number of pupils per teacher*	15.7	16.9	0.0	13.6	21.0	16.6	11.3	12.6	12.1
1929-1930									
Second class:									
Number of teachers	43	56	3	33	44	10	64	36	27
Schools reporting classes	42	53	3	32	39	10	63	34	27
Averages	1.0	1.1	1.0	1.0	1.1	1.0	1.0	1.6	1.0
Number of pupils per teacher*	26.1	47.4	28.0	31.9	30.1	19.3	29.8	22.0	18.2

* These averages indicate approximately the size of classes in schools in cities of the third class, and to some extent in cities of the second class. But in schools in cities of the first class each teacher is likely to have two or more classes.

TABLE VIII.—College degrees of the teachers of basic sciences in the high schools of Kansas

Class of Cities, Nature of Data.	Without any degree.	With bachelor's degrees.	With master's degrees.	Degree not reported.	With B. A. degrees only.	With M. A. but with no B. S. or M. S. degrees.	Number of schools.
First class							15
Number of teachers	0	32	37	1	23[1]	11[1]	
Percentage of teachers*	0	45.7	52.8	1.4	32.8[2]	15.7[2]	
Second class							70
Number of teachers	0	133	59	4	81[1]	29[1]	
Percentage of teachers*	0	67.9	30.1	2.0	41.3[2]	14.8[2]	
Third class							146
Number of teachers	1	247	31	6	139[1]	7[1]	
Percentage of teachers*	0.4	86.7	10.9	2.1	48.8[2]	2.5[2]	

* These are percentages of the total number of teachers teaching basic science unless otherwise indicated.

1. Each of these values is the number of science classes taught by teachers with the B. A. and M. A. degrees.

2. These values are obtained by dividing the values described in footnote (a) of Table II by similar values for all science teachers.

The status of education in the basic sciences in Kansas high schools is not only a matter of enrollment and opportunities for enrollment. It is largely a matter of science teachers as well. The number of teachers, the average number of teachers per school, and the number of pupils per teacher for each of the several sciences for schools covered and reported appear in table VII. These data require little explanation. The number of pupils per teacher in schools in cities of the third class possibly indicate approximately the size of the classes and therefore something about the teaching load. However, the *number* of classes taught by each teacher in each of the different sciences was not covered by this study. In addition it should be noted that in schools in cities of the third class the teachers of science courses were much more likely than the teachers of science in cities of the first class to teach other courses as well as science. The total number of teachers teaching any science courses was 12.3 percent of the equivalence of full-time teachers in cities of the first class, 19.7 percent in cities of the second class and 37.3 percent in cities of the third class.

It is clear from table VIII that there were practically no teachers of science in Kansas high schools who did not have bachelor's degrees unless those who did not report on degrees were without degrees. It is interesting to note that in cities of the first class 52.8 percent of the teachers had master's degrees, whereas only 10.9 percent in cities of the third class had such degrees. It appears, also, in this table that much science teaching was done by teachers who had only bachelor of arts and master of arts degrees. This condition might have been a serious weakness if it meant that the college preparation of those teachers in science was deficient. Data on this point are presented in table XII. The percentages of the teachers of each science who had no science degrees may be observed in table IX. It will be seen that these percentages were large in some of the schools and in certain science courses.

Successful teaching in any particular subject, however, is probably much more a matter of semester hours of college preparation in that particular subject than in the degree which the teacher holds. The average number of semester hours of college preparation per teacher (whose hours of preparation were reported) for each of the particular science courses taught in September, 1936, is shown in table X. It is apparent that these averages drop sharply in all sciences as we go from schools in cities of the first class to schools in cities of the third class. This condition was no doubt unavoidably due to two facts: (1) smaller schools in cities of the second and third classes, and (2) the much larger percentages which the number of science teachers were of all the high school teachers in cities of the second and third classes. But the quartiles of the semester hours of college preparation which are presented in table XI indicate that 25 percent of all science teachers in high schools in cities of the third class were below the Q_1 values indicated. And these values range from 4.5 to 9.2 semester hours. It is to be regretted that no data on hours of preparation were reported in the high school principals' organization reports for the school year 1929-1930. There may have been a considerable improvement since that time. What might have been the causes of this condition is beyond the knowledge of the writer of this manuscript. Only authorities on secondary education probably realize all the factors involved. However, it should not be ignored that the Q_3 values were high and the highest 25 percent of science

TABLE IX.—All high school science teachers having only the bachelor of arts and master of arts degrees, 1936-1937

Class of Cities, Nature of Data.	Agri-culture.	Biology.	Botany.	Chem-istry.	General science.	Physical geography.	Physics.	Physi-ology.	Psy-chology.
First class:									
Teachers with—									
B. A. degrees	0	7	3	3	0	0	5	2	3
M. A. degrees	0	4	0	4	0	0	1	1	1
B. A. percentages*	0.0	25.0	42.9	18.8	100.0	0.0	29.4	33.3	27.3
M. A. percentages*	0.0	14.3	0.0	25.0	0.0	0.0	5.9	16.7	9.1
Second class:									
Teachers with—									
B. A. degrees	4	16	1	10	16	2	16	8	8
M. A. degrees	1	5	0	6	3	0	8	2	4
B. A. percentages*	18.2	24.6	25.0	27.0	42.1	28.6	29.1	33.3	30.8
M. A. percentages*	4.6	7.7	0.0	16 2	7.9	0.0	14.5	8.3	15.4
Third class:									
Teachers with—									
B. A. degree	23	25	0	2	33	3	22	16	15
M. A. degrees	0	2	0	0	2	0	2	0	1
B. A. percentages*	38.3	35.2	0.0	33.3	42.9	50.0	30.6	47.1	34.9
M. A. percentages*	0.0	2.8	0.0	0.0	2.6	0.0	2.8	0.0	2.3

* The percentages which B. A. and M. A. teachers are of all science teachers for each science.

TABLE X.—Semester hours of college preparation of high school teachers for the science courses they were teaching, 1936-1937

CLASS OF CITIES, NATURE OF DATA.	Agri-culture.	Biology.	Botany.	Chem-istry.	General science.	Physical geography.	Physics.	Physi-ology.	Psy-chology.
First class:									
Average (Net N)	17.0	35.3	38.0	38.4	0	43.0	16.2	13.1	19.6
Net N†	1	24	7	16	0	1	17	5	8
Not reported‡	0	4	0	0	0	1	0	1	3
Average (Total N)	17.0	30.3	38.0	38.4	0	21.5	16.2	11.0	14.3
Second class:									
Average (Net N)	28.2	28.5	15.8	34.9	37.0	8.7	17.1	12.0	17.0
Net N†	22	65	4	37	38	7	55	24	26
Not reported‡	5	10	1	5	20	4	9	4	3
Average (Total N)	22.9	24.7	12.6	30.8	24.3	5.6	14.7	10.3	15.2
Third class:									
Average (Net N)	13.6	17.1	0.0	13.2	16.7	5.2	10.8	7.6	13.4
Net N†	60	71	0	6	77	6	72	34	43
Not reported‡	15	9	0	0	36	4	7	9	5
Average (Total N)	10.9	15.2	0.0	13.2	11.4	3.1	10.1	6.0	12.0

No data on 1929-1930 reports.

† Net N is the number of teachers reporting some value of 0 or above for hours of preparation.

‡ Not reported is the number of teachers who had classes in science, but omitted reporting the hours of preparation.

TABLE XI.—Quartiles of semester hours of college preparation for science subjects taught September, 1936

Class of Cities, Nature of Data.	Agri-culture.	Biology.	Botany.	Chem-istry.	General science.	Physical geography.	Physics.	Physi-ology.	Psy-chology.
Second class:									
Q1	9.1	16.1	0	22.3	13.1	0	10.0	5.4	8.8
Q3	35.0	37.0	0	45.5	60.6	0	21.0	19.0	20.5
Number schools	22	65	4	37	38	7	56	24	26
Third class:									
Q1	5.1	9.2	0	0	6.3	0	6.0	4.5	8.6
Q3	19.6	23.5	0	0	26.8	0	14.0	10.3	17.6
Number schools	50	71	0	6	77	3	72	34	43

teachers in semester hours of preparation were above those values. At this point it is well to observe, moreover, that the data in table XII shows that the semester hours of college preparation in science courses made by science teachers who had no science degrees do not account for either low averages or low quartiles of semester hours of preparation in science. The averages for teachers with only bachelor of arts and master of arts degrees are in the main as high as the averages for all science teachers. It is possible, however, that some teachers who had the bachelor of science degree in education were teaching basic sciences, in spite of the fact that they had no college major in basic sciences.

The status of secondary education in the basic sciences depends not only upon the data on enrollments for science courses and teachers, but upon the facilities for effective science teaching. These facilities may be thought of as time, rooms, and equipment necessary for demonstration and laboratory work. Such data, as the source used for this study provided, are presented in Table XIII. The data on laboratory periods and rooms used for laboratory purposes are clear. A comparison of the reports for the school years ending 1930 and 1937 indicates that during the intervening period there existed a definite trend toward 60-minute laboratory periods. However, the length of laboratory periods in the schools in cities of the third class for the school year ending 1937 still resembled the practice which prevailed during the school year ending 1930.

The most definite thing reported, however, concerning the adequacy of equipment for laboratory work was the annual expenditure for such equipment. The average expenditure for schools in each of the three different classes of cities, however, may mean something to teachers of basic sciences, but they indicate nothing as to what was needed, what was purchased, and what constitutes adequate equipment in nature and amount for effective teaching. Have science teachers for each of the different high school sciences agreed upon certain standards with regards to equipment? The blanket statements of *yes* or *no* concerning the sufficiency of equipment in any school may mean anything unless they refer to definite standards. The *yes* and *no* reports indicated, with a few exceptions, a general sufficiency of facilities and equipment for laboratory work in the science courses offered. The quartiles for money spent annually for laboratory equipment (see table XIV) indicate marked differences between the highest 25 percent and the lowest 25 percent of schools. In fairness to the schools in cities of the third and second classes it should be noted, by the way, that the averages per pupil enrolled for schools reporting annual expenditures for equipment were for schools in cities of the first class, 38 cents; in cities of the second class, 49 cents; and in cities of the third class, 68 cents. This is only one instance out of many which indicates the fine attempts schools in the smaller towns and cities have been making to meet the standards necessary for effective science education. The reports from schools in cities of the third class indicated only a few schools were without such laboratory facilities as gas, but about 21 percent were lacking in standard laboratory tables. About 15 percent of the schools in cities of the second and third classes at the beginning of the school year 1936-1937 had only sufficient physics apparatus for students to work in groups of three and four. However, this may have been adequate.

TABLE XII.—Semester hours of college preparation of high school teachers having no bachelor of science and master of science degrees*

Class of Cities, Nature of Data.	Agri-culture.	Biology.	Botany.	Chem-istry.	General science.	Physical geography.	Physics.	Physi-ology.	Psy-chology.
First class:									
B. A.									
Number teachers	0	7	3	3	0	0	4	2	2
Average semester hours	0.0	16.9	26.6	27.0	0	0	20.5	8.5	17.5
M. A.									
Number teachers	0	4	0	4	0	0	1	1	1
Average semester hours	0.0	43.7	0.0	44.2	0	0	15.0	29.0	23.0
Second class:									
B. A.									
Number teachers	3	15	1	9	11	1	13	7	8
Average semester hours	2.6	34.6	22.0	35.9	33.3	11.0	16.6	10.4	16.8
M. A.									
Number teachers	1	3	0	6	2	0	8	2	3
Average semester hours	1.0	34.0	0.0	27.3	62.5	0.0	12.7	9.5	14.6
Third class:									
B. A.									
Number teachers	18	23	0	2	18	2	21	13	12
Average semester hours	8.3	14.4	0.0	13.0	12.8	4.5	9.0	9.1	10.4
M. A.									
Number teachers	0	2	0	0	2	0	2	0	1
Average semester hours	0.0	35.5	0.0	0.0	23.5	0.0	22.0	0.0	19.0

* No teachers who did not report their hours of preparation were included.

TABLE XIII.—The amount of money spent annually for new equipment and for replacement of equipment for science; total number of all high school rooms; number of rooms used exclusively for science laboratories; the number of laboratory periods per week; and the frequency of different lengths of laboratory periods.

Nature of Data.	Cities of the first class, 1936-'37.	Cities of the second class, 1936-'37.	Cities of the second class, 1929-'30.	Cities of the third class, 1936-'37.
Average expenditure	$425.00	$158.06	....	$55.63
Number of schools reporting data	12	49	....	103
Laboratory periods per week	2.18	2.2	2.1	2.3
Number of schools reporting data	14	59	31	137
Average number of all rooms per school	45.0	21.4	20.4	93.4
Number of schools reporting data	13	68	68	142
Average number rooms used exclusively for science laboratories	3.4	1.8	2.4	1.0
Number of schools reporting data	14	69	70	139
Length of laboratory periods, percentages* of schools with—				
40-minute periods	6.7	2.9	1.4	8.8
50-minute periods	13.4	4.3	5.7	0.7
60-minute periods	80.0	78.6	45.7	40.1
70-minute periods	0.0	4.3	12.9	3.4
80-minute periods	0.0	5.7	20.0	38.8
90-minute periods	0.0	4.3	12.9	8.2
105-minute periods	0.0	0.0	1.4	0.0

* These time values are the mid points of class intervals. There were a few variations in time from these much more usual periods.

To the writer of this manuscript the library situation is in need of thorough study. The data obtained from the high-school principal's reports is summarized in table XV. The average number of volumes per school for each science may be adequate for good science education, but the averages surely look meager. One needs to know how many volumes were really useful for course work. The quartiles of the number of volumes on the different sciences, as shown in table XVI, indicate a marked deficiency of library books for certain sciences. Moreover, from about 25 percent to 33 percent of the schools did not report library facilities. In view of these facts it might be well to raise the question what constitutes adequate library facilities for effective education in science? Since most basic sciences are elective subjects in high schools, especially in cities of the first and second classes, the interest factor in science education is most fundamental. Are laboratory work and reading of textbooks adequate to take care of this factor in science education?

TABLE XIV.—Quartiles for money spent annually for laboratory equipment as reported in 1936-1937

CLASS OF CITIES.	Q1.	Q3.	Number of schools.
Second class	$77.70	$234.30	49
Third class	25.70	75.40	103

In conclusion it should be noted that the meaning of the facts presented in this report must depend in many cases upon factors that are peculiar to the particular sciences themselves, the requirements of the local communities, the financial abilities of the communities to pay, the attitudes of communities toward school support, the occupational condition of the communities, the interests and abilities of children, the policies of school boards, the recommendations and activities of high-school principals, state requirements for certification, general educational standards, and other less obvious and more uncertain conditions. This means that the interpretation and evaluation of these data must rest finally with those who are authorities in the basic sciences, those who know or set the educational policies of the community, and those who are authorities in secondary education. It was the aim of this study, and it is the aim of this report to present as many facts as possible about recently existing conditions. What they indicate about how well the schools were using all the means they have to do a good job of science education is not known to the members of the committee who did this study. The interpretation and evaluation of these data would probably reveal that, in the main, Kansas high schools have done well in science education. For evaluation, comparisons need also to be made with similar facts from the schools in other states.

TABLE XV.—The number of volumes for each basic science and the total number of volumes in the libraries of the high schools of Kansas

Class of Cities, Nature of Data.	Biology.	Botany.	Chemistry.	General science.	Physics.	Physical geography.	Totals of all books.
First class (1936-1937):							
Average number of books per school	149.7	89.5	73.8	80.8	50.2	26.6	6,073
Number schools reporting	13	11	13	13	13	11	13
Second class (1936-1937):							
Average number of books per school	26.5	24.8	17.3	32.7	20.0	10.5	2,506.3
Number schools reporting	60	60	62	63	62	57	56
Second class (1929-1930):							
Average number of books per school	152.0	21.2	13.3	22.8	19.7	12.3	2,030.2
Number schools reporting	1	56	57	60	64	51	64
Third class (1936-1937):							
Average number of books per school	11.7	7.84	4.51	17.7	10.5	6.6	853.6
Number schools reporting	127	110	99	135	127	124	130

TABLE XVI.—The quartiles of the distributions of the number of volumes of library books on the different sciences and on all high-school subjects*

Class of Cities, Nature of Data.	Biology.	Botany.	Chemistry.	General science.	Physical geography.	Physics.
Second class (1936-1937):						
Q1	10.0	8.0	4.4	12.5	4.1	9.5
Q3	31.0	35.5	22.6	38.4	14.6	25.0
Number of schools	60	60	62	63	57	62
Second class (1929-1930):						
Q1	....	8.7	3.7	9.5	4.4	8.6
Q3	....	28.3	16.1	26.3	17.6	24.7
Number of schools	....	56	57	60	52	65
Third class:						
Q1	4.7	3.5	2.3	6.7	4.0	5.1
Q3	17.9	7.8	6.5	24.1	9.5	14.1
Number of schools	127	110	99	135	124	127

All Library Books

		Q1	Q3		Number of schools.	
Second class (1936-1937)	....	1,392.8	3,250.0	....	56	....
Second class (1929-1930)	....	1,153.6	2,750.0	....	60	....
Third class (1936-1937)	....	490.0	1,094.2	....	130	....

* Through an error in copying data, agriculture, physiology, and psychology were omitted.

The Third Dimension in the Teaching of Biology

SISTER M. ANTHONY PAYNE, O. S. B., Mt. St. Scholastica College, Atchison, Kan.

DYNAMIC FIELD

Biology, the science of life, a discourse on living things, is a subject which, if correctly presented, interests all thinking individuals. The determination of sustained interest, however, in the biological field, depends in whole or in part on effective presentation of elementary biological data. The biology teacher who knows the field thoroughly, who likes to teach it, who has good technique and is imbued with correct philosophical principles, is in a position to teach courses in biology efficiently and effectively.

Many students who begin a course in biology have been interested in birds, flowers, and animal life for some time. They have delved into nature's secrets, have stored up much factual information, and are filled with resolve to emulate the great scientists of the day. Such students are ready for organized authentic and scientific information. They need capable, unselfish teachers.

It is the duty and prerogative of the science teacher to introduce the student to life problems and to live problems—to the field of biology. This field is not an easy one to teach, because the subject matter is difficult to present satisfactorily, that is, clearly, simply, and comprehensively. Biological data is voluminous, scientific terminology heavy, morphological structures intricate, and physiological processes involved, while time is usually at a premium. Hence, the good teacher, while he thoroughly appreciates the privilege that is his in being permitted to introduce ardent youth into this dynamic field of truth, realizes, nevertheless, his own and other limitations.

The student himself presents tangible limitation. He is a product of the twentieth century. Many times he comes to us tinged with cynicism, undisciplined, self-sufficient, and overconfident. He has positive ideas and ideals. He knows and does not care to be taught. The teacher must stand by and help him formulate new principles as he lives life's daily lesson. Usually the student discovers that the book of life is not repellant, and under the guidance of a skillful teacher, he acquires healthy, hopeful, and reverent attitudes.

It would be interesting and profitable to discuss the objectives and scope of an ideal course in biology, a course that would infallibly raise the student to a higher plane; imbue him with a deeper and holier appreciation of living things, and fill him with an earnest amibition to give his best self to life. It may be that such an ideal course will never be realized, but any contribution, any method that simplifies the teaching of science, that gives the student truer knowledge, that arouses deeper interest in life processes, proceeds toward that goal and has, therefore, inherent value.

Several years ago, in one of his interesting papers, Doctor Baumgartner demonstrated to a group of teachers that the best technique in teaching elementary courses in biology calls for the use of many living specimens. Such material enables the student to see the live animal as it really is. He visualizes the length and breadth and depth, measures and handles the specimen and abstracts correct concepts. However, it is practically impossible to keep all man-

Trans. Kansas Acad. Science, Vol. 41, 1938.

ner of living animals and plants in the laboratory for ten months of the year. There is neither room for the specimens nor time to take care of them. Hence, the majority of teachers have recourse to various kinds of substitutes: diagrams and charts, histological preparations, mounted protozoa, skeletons and skins, etc. They are all good and have definite teaching value, but there are limitations. Frequently the concept which the student derives when using such material is far from being a facsimile of the object as it exists in nature. He sees the object illustrated in two planes and he constructs a mental image similar to the representation. He has not learned to project the third dimension. He habitually visualizes in terms of length and breadth. A paramecium, a germ cell, a lily ovary lack depth. All of his biological ideas lack depth, are flat. They do not exist in nature. The student's scientific knowledge is erroneous and superficial. It also lacks depth. Are such students in a position to draw comprehensive conclusions or to make philosophical applications?

BIOLOGICAL MODELS

It is my purpose today to discuss and demonstrate a simple scientific method that has, I believe, great value in the teaching of biology. It is an old method, a form of visual aid that is not being utilized as freely or as extensively as it deserves to be. The various kinds of biological models that are on the market today are visual aids that present the organism in three dimensions, thereby helping the student to think in terms of length and breadth and depth.

Models have been advertized extensively and have been used by certain teachers for years. Those who possess a few models are usually anxious to add to their collection, for they know from experience that a student's knowledge of a vertebrate heart, for example, is much more complete after he has checked the right and left half, the auriculoventricular valves, the delicate chorda tendineae, and the pillarlike columnae carneae, etc., of a good heart model. So it is with the eye, the cell, the paramecium, and the flower. The student studies the model which presents the object in three dimensions and abstracts mental images which more nearly correspond to objective reality.

Now, granting that the common experience of teachers support these assertions, it is advisable that all science laboratories be supplied with an extensive variety of models. Unfortunately, many of the models on the market are quite expensive, and some biology budgets are in a continuous state of chronic deflation. Models cannot be purchased, but something has to be done. The good biology teacher has learned early in his carreer that he has to be resourceful, that he is often called upon to act as a "ways and means" committee of one. In this instance he must discover a way to supply the laboratory with models. It can be done, for accurate, interesting, and valuable models can be made, in the laboratory, by the student, easily, cheaply, and scientifically.

LABORATORY TECHNIQUE

There are several clays on the market that are quite satisfactory for modeling.[1] They require no firing and become very hard in twenty-four to forty-eight hours. Series of cells showing phases of mitosis, various kinds of protozoa, hydras, earthworms, flower parts, embryos, etc., can be modeled by

1. American Art Clay Co., Indianapolis, Ind. Mexican Pottery Clay.

the students in one or several laboratory periods. Directions for obtaining the best results accompany each package of clay and we have found that glycerine is an excellent medium for manipulating and smoothing the clay. When the models are dry, several coats of correctly colored enamel are applied and distinctive touches added to make the models as realistic as possible. Then they are ready to mount.

Artistic bases can be turned out for the models by the manual training classes, or simpler bases purchased reasonably. Bases made from various kinds of wood in natural finish are of value in themselves as botanical specimens. The finished products are usually well worth the time and effort and are quite serviceable in the biology department.

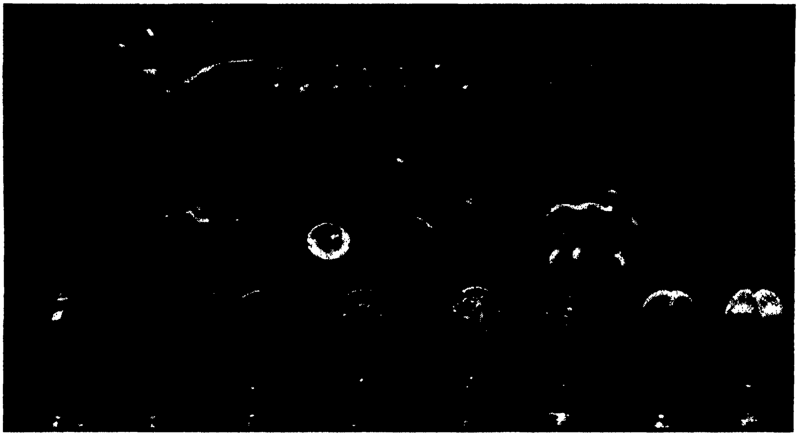


FIGURE 1

Upper row: Left, diagramatic flower; center, set developmental stages of frog; right, hydra.
Second row: Center, egg and sperm.
Third row: Front left, paramecium, vorticella, euglena, trypanesomes; right, amoeba.
Fourth row: Set illustrating cell division.

AIMS AND RESULTS

The primary aim in encouraging students to undertake projects of modeling in the laboratory is to help them acquire correct and detailed knowledge of the objects to be modeled. Students must *know* that which they reproduce in clay. Details of structure that have escaped attention during hours of study with charts or even with living specimens, command attention when they have to be constructed in three dimensions. In modeling the paramecium, for example, the careful student discovers that the outer surface of the pellicle is formed of parallel rows of small hexagonal areas and that a cilium projects from the depressed center of each of these areas.

Secondary aims in encouraging modeling projects are to awaken creative ability, and to acquire a representative teaching collection of laboratory

models. The student who produces a good piece of work is satisfied. He has expressed himself. He has accomplished something. He has helped himself attain a deeper knowledge of one organism and his handiwork will enable fellow students to grasp details of structure more clearly and more rapidly. The handiwork of the successful student will be emulated by others. The number of models increases. In a few years a fine teaching collection of valuable models, each with an interesting history, will have accumulated in the laboratory.

Susceptibility of Mature Chickens to Tapeworm Infections[1]

J. E. ACKERT and A. A. CASE, Kansas State College, Manhattan, Kan.

While studying the biology of the chicken cestode, *Raillietina cesticillus* (Molin), Ackert and Reid (1937) found that growing chickens developed an age resistance to the growth of the tapeworms. As only immature fowls were used in those experiments, and as mature chickens swallow the intermediate hosts (mostly beetles) of the tapeworms, the experiments here reported were carried out to ascertain if adult chickens are susceptible to tapeworm infection.

MATERIALS AND METHODS

The experiments were conducted in the animal house, a tightly screened, framed structure with cement floors. To this house the fowls were brought as day-old chicks from a commercial hatchery, given an adequate ration and raised in confinement under conditions slightly modified from those described by Herrick, Ackert and Danheim (1923). The ground beetles (Carabidae) were collected at some distance from any poultry yard to avoid previous infection with tapeworm eggs. As the beetles were known to be cannabalistic, each one was placed in a separate container.

For sources of tapeworm eggs, the gravid proglottids of *R. cesticillus* were collected from the feces of infested chickens. The shape of the proglottids and the size and form of the eggs make them readily identifiable. Beetles placed in Petri dishes without food for 24 to 48 hours readily devour the ripe proglottids when the latter are put before them. Usually one, but sometimes two, proglottids were fed to a single beetle, which then was placed in a pint fruit jar containing about 3 inches of soil and a 2½-inch square of paper toweling to aid in maintaining soil moisture; the lid was placed loosely on the jar.

The beetles were fed upon various animal tissues, such as meat scrap and live beetles. The most satisfactory method was to place in the jar, at weekly intervals, a half dozen small experimentally reared meal beetles (*Tenebrio* sp.). Water was supplied daily to the paper toweling and the jar checked for dead beetles, food and moisture content. Under such conditions the beetles lived from 30 to 40 days.

In the bodies of the beetles the tapeworm eggs developed into cysticercoids in from 15 to 20 days. Their removal presented problems: (1) the taxonomic structures of the beetles had to be left intact, (2) humane procedure required killing the beetle before it was examined, and (3) the cysticercoids had to be removed alive and infective. Gassing the beetle also killed the cysticercoids. Continued immersion in water caused evagination of the cysticercoids which rendered them noninfective.

After some experimentation, drowning was adopted as the method of kill-

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Contribution No. 196 from the Department of Zoölogy, Agricultural Experiment Station, Kansas State College of Agriculture and Applied Science, Manhattan, Kan.
Infection as here used is the condition produced by the establishment of the matured embryonic or larval tapeworm in the corresponding host, *e. g.*, an egg infects a beetle; a cysticercoid infects a chicken. An infestation consists of the cysticercoids that develop in a beetle, or of the tapeworms that develop in a chicken.

ing the beetle. To prevent evagination of the cysticercoids, they were floated from the beetle's body cavity through an opening in the dorsum into a 0.1 percent NaCl solution. Measurements of three cysticercoids selected at random were made quickly as an identification check.

The cysticercoids to be fed to the chickens were transferred from the salt solution into gelatine capsules or upon pieces of filter paper with the aid of a capillary pipette to whose bulb was attached a Hoffman screw compressor. With a slight turn of the screw, the cysticercoids were drawn into the pipette and held there until forced into the desired place.

EXPERIMENTS

As experimental fowls, six adult single-comb white leghorn chickens, taken from a group raised to maturity in the animal house, were selected. To provide cysticercoids, 25 ground beetles (Carabidae), collected at some distance from a poultry yard, were isolated in Petri dishes, each containing a sheet of loosely placed filter paper as a moisture absorbent and hiding place for the beetle. These beetles were then placed in dark drawers for two days to become accustomed to their surroundings and to devolp an appetite. On the third day each beetle was given a fresh, egg-filled proglottid of the fowl tapeworm *Raillietina cesticillus.* After the beetle had devoured the proglottid it was transferred to a regular fruit jar habitat which more nearly approximated the beetles' regular habitats. Here they were kept for the next 25 days. Upon opening four beetles enough cysticercoids were secured to make the desired experimental feedings. The results obtained from feeding the beetles are shown in Table 1.

TABLE 1.—Summary of results obtained from feeding to each beetle one gravid (egg-filled) proglottid of the fowl tapeworm *Raillietina cesticillus* (Molin).

Beetle.	Carabidae (species).	Date fed.	Days before being examined.	Number of cysticercoids collected.
719A	*Amara fallax*	6–23–37	25	92
720A	*Amara fallax*	6–23–37	25	165
721A	*Cratacanthus dubius*	6–23–37	25	225
722B	*Harpalus* sp.	6–10–37	40	207

Feeding Proglottids to Beetles

From the proglottid fed to beetle 719A (*Amara fallax*), on June 23, 1937, 92 cysticercoids developed in 25 days (Table 1). In a similar period 165 cysticercoids developed in beetle 720A of the same species that had been given a ripe proglottid. From beetle 721A (*Cratacanthus dubius*), a larger species, 225 cysticercoids developed in 25 days from the eggs in a proglottid. After two days beetle 722B, a large *Harpalus* sp., was drowned, as the others had been, and opened in a .1 percent NaCl solution. From its body cavity 207 cysticercoids floated out, the time allowed for development having been 40 days from the time of feeding the proglottid.

In each case the cysticercoids on being removed were assembled in lots of 50 or 100 each and fed to a mature chicken before any of the cysticercoids evaginated.

That these beetles are important factors in producing the larval stage of the fowl tapeworm, *R. cesticillus,* is evident from the results shown in table 1. From only four ripe proglottids, one to each of four beetles, 689 cysticercoids were developed, an average of 172.5 cysticercoids per beetle.

Feeding Cysticercoids to Chickens

It was to ascertain if chickens (not previously infested) may become parasitized when mature that the present experiments were carried out. In feeding the cysticercoids to the chickens, the former were counted in the .1 percent NaCl solution and transferred with the pipette to a piece of moist filter paper, which was then carefully inserted into the esophagus of the chicken. The details and results of these feedings are given in table 2.

TABLE 2.—Summary of results obtained from feeding cysticercoids of the fowl cestode *R. cesticillus* to mature chickens.

Chicken.	Age when fed, days.	Number and source of cysticercoids.	Time elapsed before proglottids passed, days.	Time from feeding to examination of chickens, days.	Number of tapeworms found.
A336.....	223	50 from beetle 720A, 50 from beetle 721A,	12	268 + (living)	Still infested (date).
A331.....	223	50 from beetle 719A, 50 from beetle 721A,	85	145	50
A335.....	225	100 from beetle 722B,	25	35	15
A330.....	225	100 from beetle 722B,	12	22	4
A348..... (Control)	225 (not fed)	0	0	0	0
A351..... (Control)	225 (not fed)	0	0	0	0

To chicken A336 were given 100 cysticercoids from two beetles. Although the adult tapeworm of this species (*R. cesticillus*) is among the larger cestodes of fowls, chicken A336 passed proglottids 12 days later, showing that a cysticercoid had developed into an adult tapeworm in that time. This hen, which has retained its infestation up to the present (272+ days), is being kept to furnish ripe proglottids when needed for experimental purposes.

A similar feeding of cysticercoids was given to chicken A331. Although her feces were examined repeatedly for proglottids, none was found until 85 days after the cysticercoids had been fed. This chicken, apparently was much more resistant to the growth of the worms than was chicken A336. However, when it was examined 145 days later, it was infested with 50 adult tapeworms, all of them having been of the species *R. cesticillus.*

From the feeding of 100 cysticercoids of *R. cesticillus* from beetle 722B to chicken A335 on the same date as the previous feedings, 15 adult tapeworms were collected 35 days later upon examination of the chicken's intestine. The tapeworms matured in 25 days in this chicken as free proglottids were found at that time in the feces. This chicken (A335) thus was more susceptible to the growth of the tapeworms than was the previous one (A331).

In the last feeding of this series, 100 cysticercoids, also from beetle 722B, were given to chicken A330. As in the first test, the proglottids from the rapidly developing tapeworms began passing from the chicken on the 12th day

after feeding cysticercoids. On examining the fowl 22 days later, 4 specimens of *R. cesticillus* were found, showing that this mature chicken as well as the others fed cysticercoids, was susceptible to infection with the cysticercoids of this tapeworm.

Two mature chickens, A348 and A351 from the same group were kept in the same pen as controls and hence were not fed cysticercoids. On examination both were found to be free from tapeworms.

DISCUSSION

It is well known that adult chickens may be infested with tapeworms. In fact, most of the records on the incidence of fowl tapeworms are from examinations of mature birds. Of 1,000 mature chickens from the vicinity of Manhattan, Kan., examined by Ackert (1927), 490 or 49 percent of them were infested with tapeworms. But as chickens are known to retain infestations of cestodes for as long as 14.5 months (Ackert, 1921), it has been uncertain whether the infestations in adult fowls were acquired as immature or mature chickens. From the present tests and from the work of Cram and Jones (1929), Wetzel (1933), Ackert and Reid (1937) and of others, it is evident that either immature or mature chickens may be parasitized with the fowl tapeworm *Raillietina cesticillus* (Molin).

SUMMARY

1. In a study to test the susceptibility of mature chickens to cestode infection, 689 cysticercoids were developed in the body cavities of four beetles (Carabidae) of three genera: *Amara, Cratacanthus* and *Harpalus*. Each beetle which had been fed a single ripe proglottid of the fowl tapeworm *Raillietina cesticillus* (Molin) produced an average of 172.5 cysticercoids of the cestode in from 25 to 40 days.

2. Four mature chickens, each fed 100 cysticercoids, became infested with adult tapeworms of *R. cesticillus* in from 12 to 85 days. Two control chickens kept in the same pen, but not fed cysticercoids, were without worms. This appears to be the first carefully controlled experiment in which mature chickens have been infected with cysticercoids.

LITERATURE CITED

ACKERT, J. E. The Longevity of Fowl Tapeworms. Jour. Parasit., 7:198-199. 1921.

——— Some Intestinal Worms of Chickens and their Control. Proc. Third World's Poultry Congress, Ottawa, Canada, pp. 333-336. 1927.

ACKERT, J. E., and REID, W. M. Age Resistance of Chickens to the Cestode *Raillietina cesticillus* (Molin). Jour. Parasit., 23:558. 1937.

CRAM, E. B., and JONES, M. F. Observations on the Life Histories of *Raillietina cesticillus* and of *Hymenolepis carioca*, Tapeworms of Poultry and Gamebirds. North Amer. Vet. 10(2):49-51. 1929.

HERRICK, C. A., ACKERT, J. E., and DANHEIM, BERTHA L. Growing Experimental Chickens in Confinement. Jour. Agric. Research, 25:451-456. 1923.

WETZEL, R. (Hannover). Zur Kenntnis des Entwicklungskreises des Hühnerbandwurmes, *Raillietina cesticillus*. Deut. Tierarztl. Wchnschr. 41 (30):465-467. 1933.

Effects of X Ray upon the Snowy Tree Cricket, *Oecanthus nigricornis argentinus*

EDITH PENFIELD BEACH, University of Kansas, Lawrence, Kan.

MATERIALS USED

In the choice of materials for investigating possible chromosome breakage by X rays, the main point to be considered was that chromosomes studied should present the maximum chance for breakage. The spermatogonial complex of *Oecanthus nigricornis argentinus* Saussure, presents 19 chromosomes, 14 small elements and 5 large V-shaped chromosomes, one V being the accessory. It is quite probable that there would be a greater chance to observe chromosome alterations in the V's, since such chromosomes may represent structures formed by a fusion of two chromosomes, and would be the first to break.

Oecanthus nigricornis argentinus, an Orthopteran of the family Gryllidae, is a common "tree cricket" of the central and northern United States. Oecanthus has two broods in Kansas. Nymphs can be collected from the middle of June to the middle of August. Adults were sent to Dr. B. B. Fulton, of the University of North Carolina, for identification.

Nymphs and adults in this locality frequent ragweeds, where they may be collected by random sweeping with a net. Material for this problem was collected from ragweeds in and around Lawrence.

TECHNIQUE OF REARING AND IRRADIATION

Young ragweeds were grown in flower pots and each covered with a lamp chimney with a cheesecloth covering for the top. As the tree-cricket nymphs were collected they were placed under chimneys. Thirty-two females and thirty-one males were reared to adulthood and X-rayed before mating. The males and females were rayed at the same time and were given the same dosage. There were 6 pairs of controls. One hundred fifteen nymphs were X-rayed, 77 of which were males. Of this number, 8 died during or soon after treatment, leaving 61 for observation. The testes of these male nymphs were fixed at periods varying from two days to two weeks after irradiation and studied cytologically.

Of the 31 pairs X-rayed as adults, 14 females survived and produced eggs. *Oecanthus nigricornis argentinus* deposits its eggs in conspicuous rows in ragweed stems. These punctures are easily counted; 101 punctures were made by 14 X-rayed females, an average of 7.2 eggs each. The largest number of punctures made by any female was 20, when oviposition occurred the day following raying. The smallest number was 5, when the females laid their eggs at least three days after they were irradiated. The oviposition period averaged two weeks. From these 101 punctures, 25 nymphs emerged and 7 died after hatching, making a total of 25 percent that hatched and 17.83 percent that lived through the second instar. The 6 controls made 74 punctures, an average of 12 eggs each. Of this number, 51 nymphs emerged and 3 died, making a

Trans. Kansas Acad. Science, Vol. 41, 1938.

total of 78 percent that emerged and 71 percent that lived through the second instar.

The X-ray treatment was given under the following conditions: Broad-focus Coolidge tube with tungsten target at a distance of 13 cm. from the target and with 1 mm. aluminum and one half mm. copper filter in part of the rayings. The same voltage (50 kilovolts) and amperage (5 milliamperes) were used in all experiments. The length of treatment varied from 3 to 10 minutes. The most satisfactory results for cytological observation were secured when specimens were rayed 6 or 7 minutes. After exposures of less than 5 minutes, the number of fragmentations is relatively small and after those of more than 8 minutes the cells are badly disintegrated.

The testes of individuals irradiated as nymphs were fixed at periods varying from 2 days to 2 weeks after treatment. The material, for the most part, was fixed in Bouin's 3 and Flemming's with and without acetic and stained in Heidenhain's hematoxylin. Benda's and Feulgen's technique were used for a few slides.

EFFECTS OF IRRADIATION

1. Effects Upon Germ Cell Tissue

In tissues rayed 7 to 10 minutes and in tissue fixed seven days or longer, after irradiation, one of the most obvious effects is the suppression of cell division. The cysts become much reduced in size and in most cases contain only a few cells. Some of these cells are larger than normal and contain many small chromatin fragments, all of about the same size and shape. In many of the cysts small, degenerate cells are clumped either in the center of the cysts or at one end, with a few scattered cells at the periphery, that appear normal. Resting cells are more normal in appearance; however, here the number is greatly reduced. The fact that there are few mature sperm also shows that cell division has been suppressed. Cross sections through the entire testes show that the size of the testis is reduced as a consequence of the heavier doses.

2. Spermatogonial Chromosomes

A. NORMAL SPERMATOGONIA

The primary spermatogonia of Oecanthus are located in parallel cysts across the follicle (fig 1). Each cyst is bounded by a cellular membrane and contains a ring of resting cells. Subsequent divisions convert the cells into secondary spermatogonia and these, in turn, into spermatocytes. The spermatogenesis of the gonial chromosomes is typical of Orthoptera and need not be followed in detail here. Only the steps will be given that are useful in demonstrating X-ray effects. A typical normal metaphase plate view is shown in figure 2. During the anaphase, the chromosomes separate, the V-chromosomes separation beginning at the apex (fig. 3).

B. X-RAYED SPERMATOGONIA

Abnormal spermatogonial conditions were found in tissue fixed one, two and three days after X-raying for three to five minutes. In older cells the spermatagonia appeared normal. This would seem to indicate that early growth periods are apparently not affected by irradiation, or, if affected, the chromatin reorganizes into the normal number and shapes of chromosomes by the time the spermatogonial anaphase is reached.

Testis cells were studied from 16 X-rayed tree crickets and more than 100 spermatogonial cells were noted where fragmentation, translocation and fusion had taken place. It was found that X rays cause fragmentation in two of the large V-shaped gonial chromosomes. In one of these, the break occurs at the apex of the V, making two slightly bent rods (fig. 4). In some cases, both breaks occur in the same cell. In the other large V, fragmentation takes place a little distal to the apex, leaving a J-shaped chromosome and a bent rod (figs. 5-6). In many of the cells observed during spermatogonial anaphase the arm of the fragmented V with spindle fiber attachment goes to one cell while the segment without fiber attachment is distributed at random to the two daughter cells. These segments do not undergo longitudinal division. This means that one half of each of two homologous chromosomes passes into some cells (fig. 7).

Figures 8 to 12, inclusive, show metaphase spermatogonia where fragmentation, translocation and fusion have taken place. Figure 8 (a) shows the fusion of one of the small chromosomes to one of the large V-shaped ones. The chromosome fragment labeled (b), a fragment from chromosome 3, is characteristic of over half of the abnormal spermatogonial cells. A small rod has fused with the end of one arm of chromosome 3.

Figure 9 shows a translocation (a) from chromosome 3. Chromosome 4 has lost one of its arms, labeled b, but has gained a small chromosome by fusion. Chromosome 5 shows the fusion of two of the smaller elements.

Figure 10 shows the fusion of chromosomes 1 and 4. Chromosome 3 is again fragmented, the broken fragment (a) remaining free. Chromosome 4 has one of the smaller elements (b) fused with it. Number 5 shows the fusion of two small chromosomes.

Figure 11 shows the usual fusion of the small chromosome (a) with chromosome 1. Chromosome 3 shows fragmentation and fusion.

Figure 12 shows very similar conditions. Chromosome 1 shows a greater constriction where the fusion has taken place. Chromosome 3 has lost the fragmented portion (b). Fusion of several of the smaller chromosomes is characteristic of this cell.

It would be difficult to point out in each cell all the morphological changes that have taken place, yet it is apparent from the foregoing that certain chromosomes are most frequently affected. It is obvious, however, that the same chromosomal complex is not produced in any two cells. White ('35) found that observation of the first division after irradiation (and to a less extent the second and subsequent divisions) showed that abnormalities are different in every cell.

3. First Spermatocyte Chromosomes

A. Normal Tetrad Formation

During the telophase of the last spermatogonial division, the chromosomes become massed at the poles, each within an individual vesicle. The chromosomes elongate and expand directly into the typical prochromosome stage (figs. 14-17), at the same time losing some of their basophilic substance. From the prochromosomes, the pachytene stage develops (figs. 18, 19). In this form there is apparently no unraveling into the single spireme stage. From the

pachytene stage, the two large ring tetrads can be followed and these two chromosomes are designated as chromosomes 1 and 2 (figs. 18-26). The two long diplotene threads (figs. 22, 23) separate along their lengths. There are stages in the history of these tetrads (figs. 23, 24), when the separation is only partially complete, in which there is an appearance of chiasma, depending on the angle of view. By focusing through it is easy to see that the threads do not touch and that the appearance of chiasmatype is merely an illusion in this species. McClung ('30) drew the same conclusion from his observations on the grasshoppers. The rings shorten and thicken, forming the compact rings seen on the metaphase plate (fig. 26). During the next cell division, the halves separate horizontally through their middle, forming V's, one going to each pole.

B. TETRAD FORMATION FOLLOWING IRRADIATION

The telophase of the last spermatogonial division after X-raying appears the same as in normal material, with one exception; *i.e.*, the chromonema is much more clearly discernible, suggesting that X rays may affect the substance surrounding the actual gene-carrying material (fig. 27). This effect may account for the break.

During the diplotene stage (fig. 29), the first evidence of breaks occurs. Mohr ('19) found that early stages of the maturation division are very sensitive to radium rays in the grasshopper cells, especially during the leptotene stages. During the tetrad-forming stages of the tree cricket, fragmentation and translocation were observed, causing many chromosomes of unusual shapes and sizes (figs. 30-27). For the most part, the long diplotene threads forming the large ring tetrads separate, but usually fragment some place along their length (figs. 30-33). However, in at least 80 percent of the cases observed, tetrad number 2 (normal), is formed after irradiation by the joining of the ends of the diplotene threads without any median split. Consequently, it is impossible for this tetrad to divide. During the anaphase it passes to one of the second spermatocyte cells without division (figs. 44-45). During late interkinesis, the formation of multiples is common.

Two types of aberrations, fragmentation and fusion, are present. It is evident that breakage often occurs with rearrangement of the parts; however, in some cases the fragmented sections remain free. For the most part, multiples are formed by the union of two or more tetrads.

4. Second Spermatocyte Chromosomes

A. NORMAL CONDITIONS

When the first spermatocyte divides, the two large rings separate horizontally, two large V's going to each cell. The accessory passes into one of the daughter cells without division. Figure 38 shows the chromosomes of a normal second spermatocyte minus the X.

B. SECOND SPERMATOCYTE FOLLOWING IRRADIATION

The division of tetrads in irradiated cells presents four morphological aberrations. First, there is an unequal division of the chromatin material during anaphase, as is shown in figures 39, 41, 47, and 48; second, multiple chromosomes pass to one or both poles (figs. 39, 40, 42, 45, 46, 47, and 48); third, chromosome b (see figs. 8 and 12) passes to one pole undivided (figs. 45, 48);

fourth, fragments of the large V's pass to one or both poles of the second spermatocyte cells (figs. 40, 41, 44, 46, 48).

The unequal movement of chromatin to the second spermatocyte cells may account for the elimination of part of a chromosome in a cell and its descendants Patterson ('30), as well as for the elimination of an entire chromosome Mohr, ('32); Mavor, ('21).

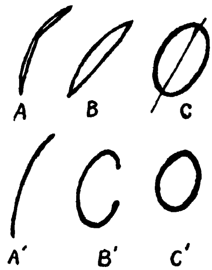


FIG. 1

Second, the fact that multiple chromosomes pass to one or both poles causes, in part, the unequal division of the chromatin mentioned above. However, in the case of multiple chromosomes, there would be lack of segregation of homologous chromosomes that would increase the chances to form lethal gametes.

Under the third aberration mentioned above, the passage of entire tetrads to one pole, reference is made to an entire tetrad not in multiple formation (figs. 44, 45). Normally during the diakinetic stage, the long threads separate with ends attached, thus forming a ring. After irradiation, in many cells, this tetrad is formed by the joining of the two ends, (text fig. 1). Since normal division results from a separation at the places where the ends join, (text fig. 1c) it is quite evident that division of the abnormal tetrad C^1, would be impossible. White ('35) mentioned ring chromosomes among the rarest abnormalities found in *Locusta migratoria* L., stating further as a possible explanation for their scarcity, that regular anaphase separation is difficult or impossible in rings. Mohr ('19) found that after radium irradiation, tetrads passed undivided to daughter cells. Helwig ('30) mentioned a closed-circle multiple.

In regard to the fourth point under discussion, the passing of fragments of the V's to one or both poles, attention is called to the effect of X rays on the spermatogonial cells. Breakage occurred in spermatogonial V's before the normal separation of the diads. The arm of this diad to which the spindle fiber is attached separated in the subsequent division, half of each arm going to each daughter cell (fig. 43). Chromosomes labeled (s) are the two arms of the V that have separated, giving one half of a normal monad to each cell Chromosome (d) without fiber attachment has remained a diad, as shown by its thickness, and it remains by chance in one of the daughter cells (figs. 43, 49 and 51).

CONCLUSIONS

1. There are two generations of snowy tree crickets each season in Kansas,
2. Irradiation of adults reduces the number of eggs laid and the number of nymphs to emerge almost one half.
3. Irradiation inhibits cell division, reducing the number of dividing cells and causing the formation of large cells with many chromosomes in some cases.
4. Chromosomes show a marked tendency to fragment after exposure to X ray.
5. Abnormal spermatogonial cells were found only in cells fixed one, two and three days after raying, suggesting that late growth periods are affected most.
6. In spermatogonial cells, irradiation causes fragmentation in two of the large V-shaped chromosomes.
7. Translocation was found in spermatogonial cells exposed to rather heavy doses.
8. Multiple chromosome formation occurred at synapsis.
9. Four types of aberrations were found in second spermatocyte cells.
10. The earliest evidence of chromosome breaks occurred in the diplotene stage of the first spermatocyte division.
11. The history of the two large ring-tetrads was traced through the spermatocyte stages. No unravelling stage was found. The pachytene threads seem to form (double) immediately out of the prochromosome stage. No evidence for chiasmatype was found.
12. Evidence for delayed breakage was found.
13. Some evidence was found which may show that breaks are caused in part by the effect of the X rays upon the chromosome matrix.

LITERATURE CITED

DOBZANSKY, T. 1931. The decrease of crossing-over observed in translocations, and its probable explanation. Amer. Nat. 65:214-232.

HANSEN, F. B. 1928. Effect of X rays on productivity and the sex ratio. Amer. Nat. 62:353-362.

HELWIG, EDWIN R. 1933. The effect of X ray upon the chromosomes of *Circotettix verruculatus* (Orthoptera). Jour. Morph. 55:265-311.

MCCLUNG, C. E. 1930. Multiple chromosomes in the Orthoptera. Actus Cong. Inter. Biologica 7:1-18.

MAVOR, J. W. 1921. On the elimination of the x-chromosome from the egg of *Drosophila melanogaster* by X ray. Soc. Exp. Biol. and Med. 18:301-302.

MOHR, O. L. 1932. Genetical and cytological proof of somatic elimination of the fourth chromosome in *Drosophila melanogaster*. Genetics 17:60-80.

——— 1919. Mikroskopische Untersuchungen zu Experimenten über den Einfluss der Radiumstrahlen und der Kaltewirkung auf die chromatin reifung und das Heerochromosom bei Decticus verruccivorus. Archiv f. mikr. Anat. 92:300-368.

MORGAN, L. V. 1925. Polyploidy in *Drosophila melanogater* with two attached V-chromosomes. Genetics 10:148-178.

MULLER, H. J., and E. ALTENBURG. 1930. The frequency of translocations produced by X rays in Drosophila. Genetics 15:283-311.

Muller, H. J., and A. L. Dippel. 1926. Chromosome breakage by X rays and the production of eggs from genetically male tissue in Drosophila. Brit. Jour. Exp. Biol. 3:85-122.

Muller, H. J. 1928. The production of mutations by X rays. Proc. Nat. Acad. Sci. 14:714-726.

Navashin, M. 1931. A preliminary report on some chromosome alterations by X rays on Crepas. The Amer. Nat. 65:243.

Painter, T. S. 1928. The chromosome constitution of the Little and Bagg abnormal-eyed mice. Amer. Nat. 62:284-286.

Patterson. J. T. 1935. The question of delayed breakage in the chromosomes of Drosophila. The Jour. of Exp. Zoöl. 70:233-242.

——— 1930. Somatic segregation produced by X rays in *Drosophila melanogaster*. The Nat'l Academy of Sciences Proc. 16:109-111.

Plough, H. H. 1917. The effects of temperature on crossing over in Drosophila. Jour. Exp. Zoöl. 24:147-209.

Robertson, W. R. B. 1916. Taxonomic relations shown in the chromosomes of Tettigidae and Acrididae, Locustidae and Gryllidae; chromosomes and variations. Jour. Morph. 27:1179-280.

White, M. J. D. 1935. The effects of X rays on mitosis in the spermatogonial division of *Locusta migratoria* L. Proceedings of the Royal Society of London, Series B, 119:61-84.

EXPLANATION OF PLATES

The figures were drawn at approximately 2,275 magnification. A camera lucida was used with a Zeiss microscope, 2 mm. apochromat oil-immersion lens and No. 20 × oculars. Drawings were made on a level with the mechanical stage. Figures were reduced about one half.

Figures in each horizontal row in plates 4 and 5, represent the chromosomes of one cell, and chromosomes in each vertical column (A-J) represents corresponding chromosomes from different cells. Column D shows the sex-chromo-

PLATE I

FIG. 1. Follicle.

FIG. 2. Metaphase plate view of normal spermatogonia, showing 14 small chromosomes and 5 large Vs. One V is the accessory.

FIG. 3. Normal dividing spermatogonia.

FIGS. 4-6. X-rayed cells showing fragements of two V-chromosomes.

FIG. 7. Spermatogonial division after irradiation. An arm of the fragmented V with spindle fiber attachment goes to one cell without lengthwise division. The other segment wanders and by chance enters one of the cells.

FIG. 8-12. Metaphase spermatogonia showing fragmentation, translocation and fusion.

FIGS. 13-20. Normal tetrad formation.

PLATE I

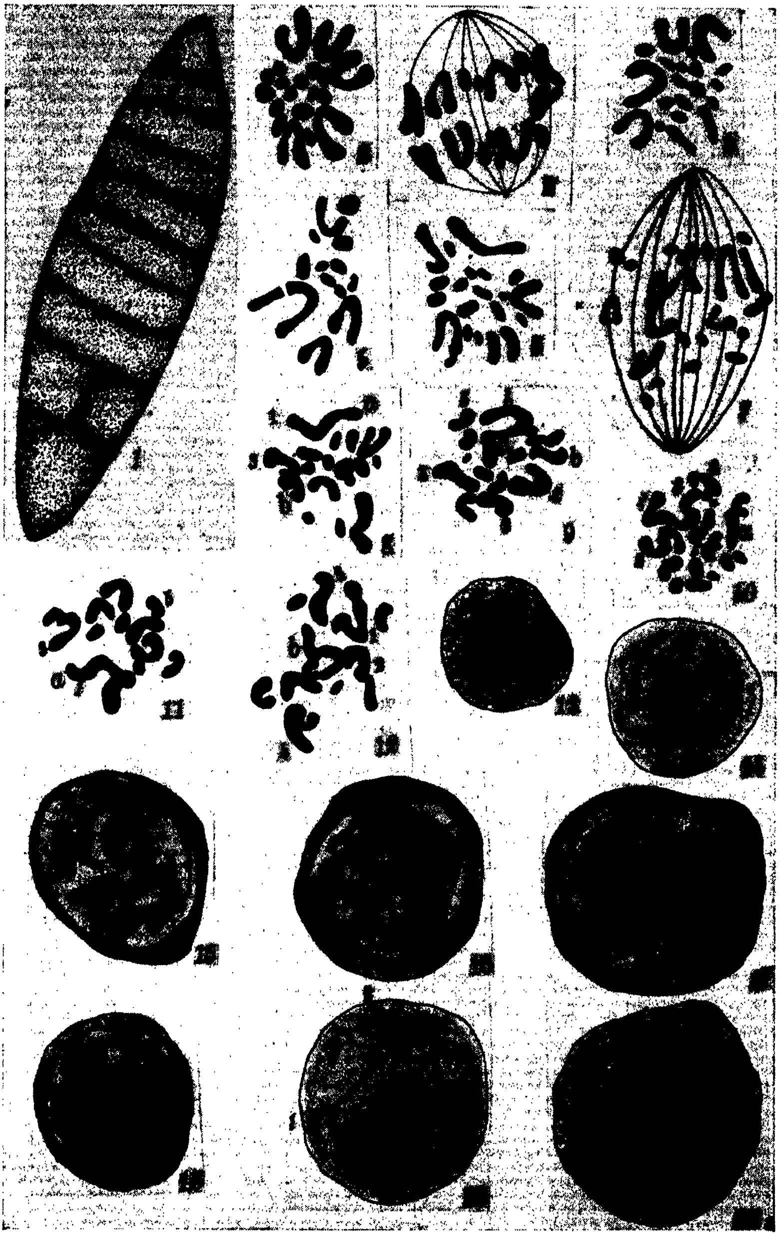


PLATE II

FIGS. 21-26. Normal tetrad formation showing development of the two large ring-tetrads.

FIG. 27. Late telophase after irradiation, showing the cromonema more clearly than in the normal tissue.

FIG. 28. Early diplotene stage.

FIG. 29. Diplotene stage, showing first evidence of a break.

FIGS 30-37. Effects of X ray upon tetrad formation.

FIGS. 33, 34, 36 show the abnormal formation of one of the rings. The ends join without the usual median split as in figs. 23, 24 (normal).

PLATE II

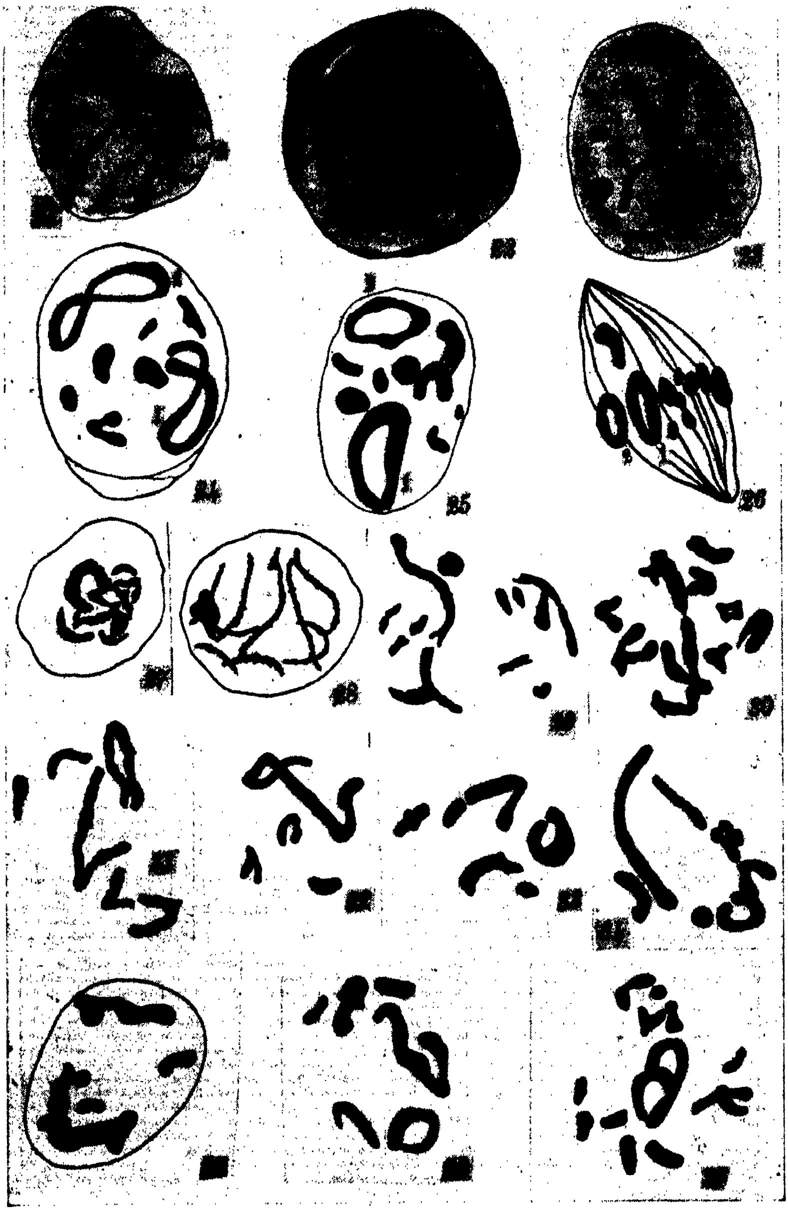


PLATE III

FIG. 38. Normal second spermatocyte without accessory.

FIG. 39. Unequal division of chromatin during second spermatocyte anaphase.

FIG. 40. Tetrads pass to the poles without division.

FIG. 41. Unequal division of chromatin.

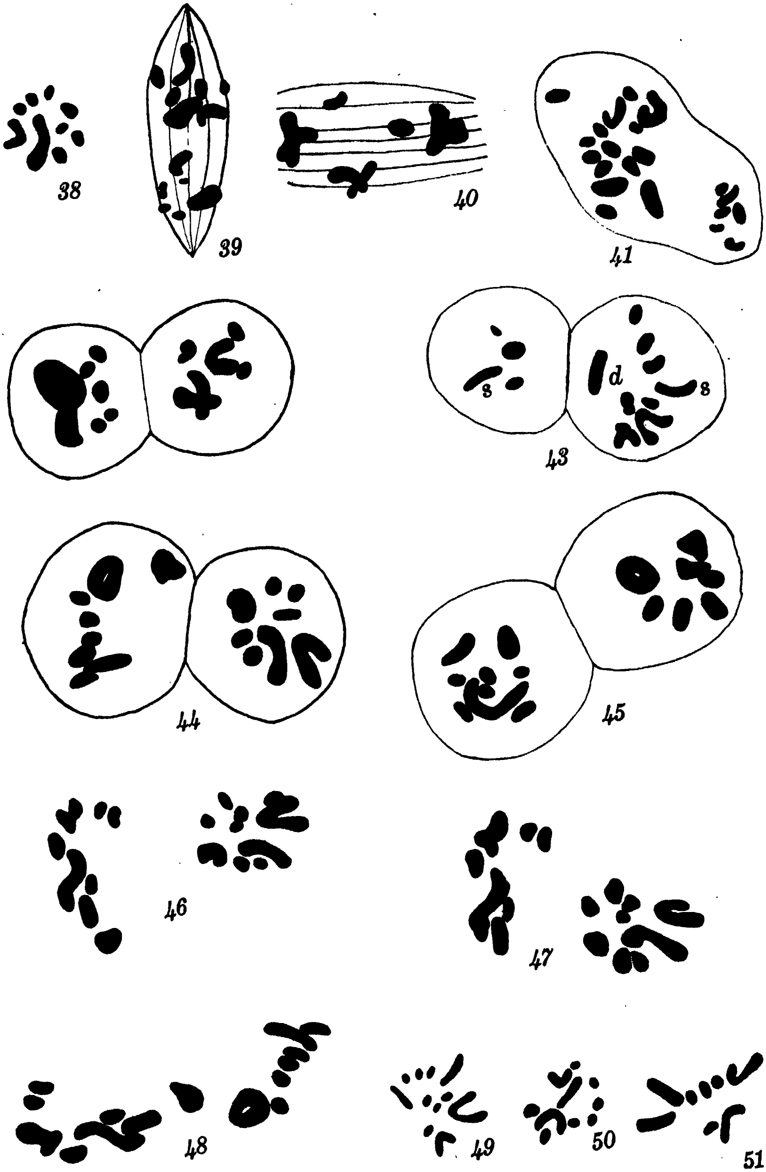
FIGS. 42, 39. Multiple chromosomes pass to both poles.

FIGS. 43, 44. An arm of the fragmented V has passed to each pole. Second spermatocyte division.

FIGS. 44, 45. The abnormal ring tetrad has passed to one pole without division.

FIGS. 46-51. Abnormal second spermatocyte cells after irradiation.

PLATE III



Effects of Nicotine on Rats (Albino)

HAZEL ELISABETH BRANCH and W. GLEN MOSS, University of Wichita, Wichita, Kan.

Encouraged by the results dealing with the influence of the oral administration of alcohol upon the litter mortality of white rats (2), and stimulated by statements concerning the influence of cigarette smoking upon weight as well as upon the offspring of human beings, the author made some preliminary experiments with the oral feeding of nicotine to see if results would justify further and more elaborate experimentation.

The results of this preliminary work (reported below) showed an interesting factor in litter reduction, and further experimentation was decided upon.

Experiments during 1936-'37, as first outlined, were to include weights and litter mortality, but were later extended to cover investigations in the oestrus cycle and the changes in the cytology of the anterior pituitary gland. The reproductive organs as well as adrenal glands, mammary glands, thyroid gland, and spleen were preserved for further check if needed.

THE PRELIMINARY EXPERIMENTS

Experiment I

From a normal litter born November 10, 1933, six females and two males were taken on December 8, 1933, at 28 days of age and separated into two groups with as near the same weight as possible:

Experimental	Control
3 females and 1 male.... 199.7 gms.	3 females and 1 male... 202.85 gms.
Average: 49.0 gms.	Average: 50.7 gms.

Nicotine[1] was fed with a dropper known to discharge (in a given position) 20 drops to 1 c.c. This nicotine was diluted 1-20 with water and 6 drops of this solution were diluted 6-100 with water (one drop of this dilution equals .15 mg. of nicotine) and one drop was fed at each of five feedings over 10 hours of the day.

The animals were housed in adequate cages[2] and in a room connected with (and heated the same as) the laboratory of the zoölogy department of the science hall.

The food was carrots, lettuce, yellow corn, milk, bread, and table scraps of meat and potato. All was carefully divided between the two groups, which were kept separate, although the male and the females of each group were housed together.

The controls were fed water by pipette whenever the experimentals were given nicotine.

The nicotine dilution was raised until 1.2 mg. was contained in each drop of liquid fed on January 20, 1934, and this dilution was held until March 7, when the experiment was discontinued.

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. The nicotine used was a Merck product bearing the label:
6751 Nicotine 'Merck'—extra pure 4a
E. Merck 82420 Darmstadt
Made in Germany

2. Will Corporation No. 1172.

WEIGHT INCREASES

	Experimental		Control
Average	49.9 gms.	November 10	50.7 gms.
	71.9 gms.	December 15	69.15 gms.
	154.35 gms.	January 7	158.3 gms.
	209.61% gain		212.22% gain

LITTER RESULTS

Experimental Date	Born	Weaned	Control Date	Born	Weaned
Female A, Jan. 29	15	0	Female A, Feb. 6	8	8
Female B, Feb. 3	10	0	Female B, Feb. 12	10	10
Female C, Feb. 15	10	10	Female C, Feb. 25	12	12
Female A, Feb. 25	12	0			
Female B, March 2	12	3			

Litters, 5; born, 59; weaned, 13—22.4% weaned.

Litters, 3; born, 30; weaned, 30—100% weaned.

As there may be some question concerning the strength of experimental females A and B for the second litters, it will be only fair to compare the first three litters. This shows 35 born and 10 weaned, or 28.5 percent, as against the 100 percent of the control. The average litter weight of experimental female C at ten days was 32.8 gms. The average litter weight of control female B at ten days was 34.8 gms. (These litters were chosen as the conditions of heat, food and weather are the most nearly comparable.) The laboratory stock during this same period showed:

Date	Born	Weaned
Feb. 1	8	8
Feb. 5	8	8
Feb. 9	8	8

and we record it here as a check on the chance loss of a litter in stock which would cause us to hesitate in considering the nicotine as the sole cause of the loss of the litters in the experimental group.

A second generation experiment was run on the living rats of experimental female C. There were six males and four females. Four males were killed and the remaining two housed with the four females. The results were as follows:

	Date	Born	Weaned
Rat C 1	July 3	3	3
Rat C 2	July 4	2	0
Rat C 3	July 5	4	0
Rat C 8	July 8	8	0

17 born and 3 weaned—17.6%

Experiment IB

Although not producing data to be used in a general average of results of litters living until weaning time, interesting observations may be drawn from a reversal of experiment I, in which the experimental group of females were freed from nicotine on March 7 and nicotine was administered to the control group.

Freed Experimentals	Born	Weaned	Nicotined Controls	Born	Weaned
Female A, March 26	13	13	Female A, March 13 ...	8	7*
Female B, April 7.......	8	5	Female B, March 16 ...	16	11
Female C, April 25	10	10	Nicotine stopped April 26.		
			Female C, June 22......	6	0
			Female B, July 15	6	6
No more litters to July 26.			Female C, July 23	6	6

Experiment II

The individuals for this experiment are from the litter of control female B of Experiment I—6 females and 4 males were taken, separated into two groups, each composed of 3 females and 2 males.

The experiment was started March 20 at the age of 38 days, with experimentals averaging 59.09 gms. The controls averaged 53.6 gms. from March 20 to April 3—nicotine in dilution to make 3 mgms. in a single dose (two times the content of one of the five daily doses given in Experiment I and 40 percent of the whole daily amount) was fed. On April 3 the amount of the dose was raised to 6 mgms. and held until April 26, when it was stopped until May 12. The nicotine feeding was resumed May 12 with one daily dose of 3.0 mgms. and held until July 24, when the experiment was discontinued.

Experimentals	Born	Weaned	Controls	Born	Weaned
Female No. 1, July 20....	8	7	Female No. 1, May 31..	4	4
Female No. 2, July 24....	5	4	Female No. 2, June 21..	3	3
Female, No. 3, July 24....	5	0	Female No. 3, June 2..	7	7
			Female No. 1, July 22..	10	10
Females	18	11	Females	24	24
Weaned, 61.1%			Weaned, 100%		

WEIGHT RECORDS

Experimentals		Controls
59.09 gms.	March 20	53.6 gms.
62.91 gms.	March 27	65.51 gms.
87.1 gms.	April 14	89.1 gms.
47.4%	Gain	66.2%

SUMMARY—All Litters

Experiment I

Experimentals	Born	Weaned	Controls	Born	Weaned
Female A, Jan. 29........	15	0	Female A, Feb. 6......	8	8
Female B, Feb. 3........	10	0	Female B, Feb. 12......	10	10
Female C, Feb. 15........	10	10	Female C, Feb. 25......	12	12
Female A, Feb. 25........	12	0			
Female B, March 2.......	12	3		30	30
	59	13			

Experiment II

Experimentals	Born	Weaned	Controls	Born	Weaned
Rat No. 1, July 20........	8	7	Rat No. 1, May 31......	4	4
Rat No. 2, July 24........	5	4	Rat No. 2, June 21......	5	3
Rat No. 3, July 24........	5	0	Rat No. 3, June 22......	8	7
			Rat No. 1, July 22......	10	10
	18	11		27	24
Total	77	24	Total	57	54
31.1 percent weaned			94.3 percent weaned		

* All very scrawny, and on April 9 mother died and the average weight 22.2 gms. We hand fed, and by April 14 had brought weight to 34.02. Killed June 6.

FIRST LITTERS ONLY

48.4 percent weaned	93.6 percent weaned
Rats Per Litter	
8 litters: 77 born, 24 weaned	7 litters: 54 born, 54, weaned
Average: 9.87 born; 3 weaned	Average: 8.14

EXPERIMENT III

The summary of a third experiment based on the same method as Experiment II and conducted in the summer of 1933 is included in a grand total.

Experimentals					Controls			
Litters.	Born.	Weaned.	Died.		Litters.	Born.	Weaned.	Died.
5	59	13	46	I	3	30	30	0
3	18	11	7	II	4	27	24	3
5	48	13	35	III	4	32	24	8
13	125	37	88		11	89	78	11
29.6 percent weaned					90.6 percent weaned			

Less than a third as many survived. (The results of these experiments were reported to the Academy at the 1935 meeting).

CONCLUSION

The rats fed nicotine show a higher litter mortality than the control. A greater rate of loss is shown in the cases where the dosage is spread through the day rather than taken in one large dose, even though that may be four to eight times as great. The heavy single dose appears to retard pregnancy or at least presentation of litter.

The percentage gain in weight, for six weeks, is higher in the controls.

EXPERIMENTS 1936-'37

As the foregoing experiments seemed to indicate that the matter is worth further investigation, larger experiments were conducted in the fall of 1936 and the summer of 1937.

Four experiments were conducted, using a new supply of nicotine from the same source and bearing a label the duplicate of that used in 1933-'34. The animals were housed in exactly the same room and under the same conditions, with the exception that Purina Dog Chow was used as a basic diet, interspersed with the table and kitchen scraps from the University Commons. These were gathered just after the lunch hour and contained lettuce, celery refuse, and apple parings, besides bread, meat and potato scraps. Water was available in the cages at all times by means of bottles with tube outlets (8) and a student helper was added to produce as much regularity and uniformity to the care and treatment as possible. The nicotine was administered with a pipette known to yield 20 drops to the cubic centimeter, and the controls were fed water by pipette to duplicate the handling given the experimental animals.

The rats in the experiments were from the same stock as the previous experiments and were bred in this laboratory.

EXPERIMENT A

This experiment was started October 23, 1936, with a mixture of three litters of normal rats born August 26, 27, 29, 1936, consisting of 15 males and 11 females, separated into an experimental group of 8 males and 5 females and a control group of 7 males and 6 females (55 to 58 days of age).

The nicotine was administered in a dilution beginning with 5 drops of nicotine to 95 drops of water and raising this each week by adding one more drop of nicotine and reducing the water by one drop. One drop of this was fed to each male and to each female just before feeding time on each of six days in the week. Commencing with the 2.5 mgms. as above, the dose was gradually raised until January 1, 1937, when the dose became 7.5 mgms., and was held here throughout the remainder of the experiment (April 30). A few convulsions and the death of two males from convulsions occurred from this dosage; therefore, we concluded we had reached a maximum dosage and should not add any more.

Experiment B

This experiment was started October 23, 1936, with two litters, each born September 19 and composed of 12 females and 6 males. These were divided into two groups of 6 females and 3 males each. These rats, 34 days old, were fed just one third the amount of nicotine as those of Experiment A by giving each one drop of a 10 to 30 dilution of the dilution given the A group. This started with a 5 to 100 dilution or 2.5 mgms., of which one third amounted to 0.833 mgms., the next week the dose of 6 to 100 divided by three amounted to 1 mgm. This continued until January 8, when the one-third dose reached the equivalent of a 5-100 dilution, and this was used and increased by one drop each week to February 19, when a 8-100 dilution, or 4 mgms. dose, was reached and held throughout the remainder of the experiment (April 29, 1937).

The housing and food of this experiment is the exact duplicate of Experiment A, the only difference being the age of the rats and size of the dosage.

Experiment C

This experiment, started March 24, 1937, was composed of sixteen males of mixed litters, twenty-six to twenty-eight days of age, and divided into two groups of eight each. Nicotine was fed in the same manner as in the other experiments, the dosage beginning with a dilution equal to one third of a 3-100 dilution or 0.5 mgms. Each week the main solution was increased by one drop until May 5, when the main solution reached 9-100, after which a drop of 3-100 was given and this increased by one drop each week until June 3 when the dosage reached 3 mgms. The experiment was discontinued at this date. All the animals were killed and organs and glands (7) of the body preserved in Bouin's fixative.

Experiment D

This experiment, started March 24, 1937, was composed of twenty-four rats of mixed litters, forty-one to forty-three days of age and was set up into two groups of six males and six females each. The nicotine dilution was started at one daily drop of a 3-100 dilution or 1.5 mgms. and increased by one drop each week until June 15 when a dilution of 12-100 or 6 mgms. was reached. The controls received a drop of water when the experimentals received nicotine. The food, housing, and care was the equivalent of previous experiments.

The results of these experiments are grouped under the following headings: 1, Litter Mortality; 2. Weights and Gains; 3, Oestrus Cycle; and 4. Cytological Changes in Anterior Pituitary.

1. LITTER MORTALITY

Table I shows the litter mortality of Experiments A and B with the percent rate of the number weaned in both the experimentals and the controls, and a summary.

Table I—Litter Mortality

The litters dropped are given in the table, with the number dropped and the number weaned in each case.

EXPERIMENT A

Experimental

Female.	Date.	Dropped.	Weaned.
A	Nov. 23, '36	5	0
B	Dec. 10, '36	9	0
B	Jan. 7, '37	7	0
B	Feb. 25, '37	6	5
C	Dec. 4, '36	8	0
C	Feb. 12, '37	9	8
E	Dec. 16, '36	10	2
E	Feb. 14, '36	8	8
F	Dec. 18, '36	7	0
F	Jan. 26, '37	9	0
F	Feb. 25, '37	7	6
		85	18

21.17% lived.

Control

Female.	Date.	Dropped.	Weaned.
A	Dec. 14, '36	7	5
A	Feb. 11, '37	7	7
B	Nov. 29, '36	4	2
B	Jan. 30, '37	11	0
C	Dec. 5, '36	7	0
C	Jan. 8, '37	6	6
C	March 8, '37	7	7
D	Dec. 5, '36	10	3
D	Feb. 12, '37	9	0
E	Dec. 7, '36	7	0
E	Jan. 11, '37	4	0
E	Feb. 5, '37	9	6
G	Dec. 17, '36	8	8
G	Feb. 9, '37	10	10
		106	54

50.9% lived.

EXPERIMENT B

Experimentals

Female.	Date.	Dropped.	Weaned.
A	Jan. 9, '37	7	0
A	Feb. 16, '37	9	8
B	Jan. 4, '37	7	0
B	Feb. 27, '37	4	4
C	Jan. 11, '37	9	0
D	Jan. 13, '37	6	3
D	March 14, '37	7	0
E	Feb. 3, '37	9	7
F	Feb. 25, '37	6	0
		64	22

34.37% lived.

Controls

Female.	Date.	Dropped.	Weaned.
A	Dec. 23, '36	7	0
A	Jan. 26, '37	9	9
A	March 16, '37	9	9
B	Jan. 4, '37	10	3
B	March 1, '37	10	0
C	Jan. 20, '37	11	6
C	March 8, '37	11	9
D	Jan. 14, '37	7	0
D	Feb. 28, '37	7	5
E.	Jan. 26, '37	12	10
F	Feb. 7, '37	7	5
		100	56

56% lived.

	Dropped.	Weaned.
Grand total (Experimentals)	149	40
Grand total (Controls)	206	111

Experimentals: 26.83% lived. Controls: 53.39% lived.

An interesting observation on litter mortality may be made in Experiment D. In this experiment material was desired for sectioning and the females were taken at 48 to 60 hours in a uniform cyclic period following parturi-

tion. The records concerning the number born and the number living when the mother was killed show:

Experimentals	Born.	Living	Controls	Born.	Living.
No. 1	5	2	No. 1	7	7
No. 2	8	8	No. 2	9	9
No. 3	8	3	No. 3	3	0
No. 4	9	9	No. 4	8	8
No. 5	6	0	No. 5	8	8
No. 6	5	5	No. 6	9	9
	41	27		44	41
65.8% living.			93.1% living.		

CONCLUSION. Nicotine, administered orally to white rats, lowers the rate of offspring surviving to weaning time.[3] This situation indicated a lack of function in the mammary glands. As these glands are considered to be under the guidance of a hormone of the anterior pituitary, further investigation will be made in this subject.

2. WEIGHTS AND GAINS

Tables II and III show the weekly observations upon the average weights and the gains over the average initial weights for the males and females (up to twenty-one days before parturition) of Experiments A and B. Tables IV and V show the weekly observations upon the average weights and the gains over the average initial weights for Experiment C, which was all males, and for the males of Experiment D.

CONCLUSIONS. *Observation on Males.* Experiments A and B which were continued over a period of twenty-seven and twenty-eight weeks, respectively, show a higher percent gain in the experimentals than in the controls. Experiments C and D were continued over ten and eleven weeeks. At 10 weeks D shows a higher percent of gain in the experimentals, but C (Table IV) shows the higher gain in the controls. This situation is produced by a sudden drop in the experimentals during the tenth week. It will be noticed from Table V that D makes a similar drop from June 4 to June 17, giving the controls the higher gain.

As the two sets of experiments cover widely different lengths of time, the end results should not be compared. However, the end results at the tenth and eleventh weeks may be taken consistently as comparable to the end results of C and D. These all show the controls with the higher gain. See Summary.

This warrants a conclusion that during a long period of time, nicotine influences a gain in weight; but for a shorter period of time the nicotine retards. This last statement is in accord with Behrend and Thienes (1), who report a slight retardation in growth of males.

Observation on Females: In Experiments A and B the weights were observed up to twenty-one days before parturition. The period of time in A was three weeks and that of B was six weeks. In both experiments the percent of gain in the controls is greater than in the experimentals.

3. This observation is substantiated by the work of Buel (4).

The results of these observations, although for a very short period, indicate retardation under the influence of nicotine. This does not agree with Behrend and Thienes (1), who report no influence of nicotine on the weight of females.

TABLE II—WEIGHT RECORD

EXPERIMENT A

	Experimentals Weight.	Gain.	Date.	Controls Weight.	Gain.
Male.....	93.96	......	Oct. 23	99.9	......
Female...	80.46	......		67.1	......
Male.....	99.37	5.41	Oct. 30	102.28	3.36
Female...	98.0	18.4		84.28	17.4
Male.....	116.0	22.1	Nov. 6	116.7	16.6
Female...	102.7	22.3		111.2	44.1
Male.....	125.4	31.44	Nov. 13	131.7	31.8
Female*..	124.4	44.0		105.4	38.3
Male.....	137.9	44.0	Nov. 20	146.0	46.1
	147.5	53.6	Nov. 27	160.39	62.49
	161.6	67.7	Dec. 4	172.8	72.9
	160.8	66.9	Dec. 11	165.6	65.7
	163.9	70.0	Dec. 18	183.3	83.4
	178.7	84.8	Dec. 26	190.6	90.7
	186.8	92.9	Jan. 2	217.99	118.09
	179.9	86.0	Jan. 8	218.3	118.4
	169.39	75.5	Jan. 15	218.7	118.8
	178.3	84.4	Jan. 22	217.2	117.3
	192.1	92.2	Jan. 30	211.2	111.3
	216.3	122.4	Feb. 12	222.2	122.3
	226.4	132.5	Feb. 19	223.1	123.2
	224.2	130.3	Feb. 26	230.2	130.3
	235.2	141.3	Mar. 5	235.3	135.4
	234.8	140.8	Mar. 12	239.0	139.1
	230.6	136.7	Mar. 19	241.4	141.5
	211.0	117.1	Mar. 27	217.7	117.8
	220.6	126.7	Mar. 30	235.7	135.8
	210.8	117.9	Apr. 5	225.0	125.1
	213.6	119.7	Apr. 9	249.1	149.1
	230.5	136.6	Apr. 16	243.1	143.2
	242.9	161.6	Apr. 23	239.2	139.3
	171.95% gain.			139.48% gain.	

* Female gain, 54.8% experimental; 57.2% control. We regret that we do not have records for nonbreeding females to correspond with the male weights for the full time. Males at same date, 38.4% gain, experimental; 31.8% control.

TABLE III—WEIGHT RECORD

EXPERIMENT B

	Experimentals Weight.	Gain.	Date.	Controls Weight.	Gain.
Male.....	36.0 gms.	......	Oct. 23	36.2 gms.	......
Female...	33.5	......		27.25	......
Male.....	46.05	10.05	Oct. 30	46.0	9.8
Female...	53.36	19.8		43.0	15.8
Male.....	60.29	24.29	Nov. 6	59.49	23.29
Female...	58.17	24.67		57.0	29.8

	Weight.	Gain.	Date.	Weight.	Gain.
Male.....	71.02	35.02	Nov. 13	76.88	40.6
Female...	64.55	31.05		66.42	39.2
Male.....	84.06	48.06	Nov. 20	92.46	56.2
Female...	84.17	50.6		89.32	62.1
Male.....	96.9	60.9	Nov. 27	108.4	72.2
Female...	96.37	62.8		99.55	72.4
Male.....	114.1	78.1	Dec. 4	122.8	86.6
Female*..	106.8	73.3		111.77	84.5
Male.....	122.74	86.72	Dec. 11	128.36	92.1
	131.8	95.8	Dec. 18	133.46	97.2
	148.6	112.6	Dec. 26	152.6	116.4
	163.1	127.1	Jan. 2	165.0	128.8
	160.0	124.0	Jan. 8	147.9	117.7
	156.0	120.0	Jan. 15	176.8	140.6
	162.0	126.0	Jan. 22	180.6	144.4
	175.6	139.6	Jan. 29	178.1	141.9
	185.6	149.6	Feb. 12	194.2	158.0
	185.0	149.0	Feb. 19	193.6	167.4
	192.6	166.6	Feb. 26	209.9	173.7
	191.7	155.7	Mar. 5	211.3	175.1
	200.2	164.2	Mar. 12	216.0	179.8
	210.3	174.3	Mar. 19	225.0	188.8
	209.0	173.0	Mar. 30	213.0	176.8
	213.3	177.3	Apr. 5	216.6	180.4
	209.8	173.8	Apr. 9	212.6	176.4
	208.2	172.2	Apr. 16	213.9	177.7
	231.6	195.6	Apr. 23	229.0	192.8
	234.3	198.3	Apr. 30	232.3	196.1
	550.83% gain.			541.71% gain.	

* Percent gain to 21 days previous to parturition: Experimentals, 219.08%; controls, 310.2%. Males of same date, 216.9%; controls, 288.4%.

Table IV—Weights and Gains

EXPERIMENT C—MALES

Experimentals			Controls	
Weight.	Gain.	Date.	Weight.	Gain.
33.3 gms.	....	Mar. 24	32.7 gms.	....
32.0	1.3	Mar. 31	35.7	3.0
38.4	5.1	Apr. 7	38.8	6.1
51.8	18.5	Apr. 14	52.3	19.6
65.8	32.5	Apr. 21	64.9	32.2
79.3	46.0	Apr. 28	78.9	46.2
107.6	74.3	May 5	107.3	74.6
129.1	95.8	May 12	132.6	99.9
139.1	105.8	May 19	143.2	110.5
162.3	149.0	May 26	157.4	124.7
165.3	132.0	June 3	172.9	140.2
	396.3% gain.		459.3% gain.	

TABLE V—WEIGHTS AND GAINS

EXPERIMENT D—MALES

Experimentals Weight.	Gain.	Date.	Controls Weight.	Gain.
79.6 gms.	....	Mar. 24	81.6	....
88.5	8.9	Mar. 31	91.5	9.9
96.8	17.2	Apr. 7	98.9	17.3
110.8	31.2	Apr. 14	141.6	60.0
118.4	38.8	Apr. 21	122.6	41.0
156.2	76.6	Apr. 28	155.2	73.6
168.0	88.4	May 5	162.5	80.9
190.6	111.0	May 12	186.9	105.3
191.6	112.0	May 19	194.8	113.2
205.1	125.5	May 26	202.1	120.5
217.9	138.3	June 4	212.0	130.4
222.3	142.7	June 17	238.2	156.6

11-12th wk., 181.8% gain. 191.9% gain.
10th wk., 186.0% 159.7%

SUMMARY

Experimentals Percent gain.	Experiment.	Controls Percent gain.
Males, 171.95	April 23—A	Males, 139.43
Males, 550.83	April 23—B	Males, 541.71
Males, 98.8	January 2—A	Males, 118.2
Males, 353.0	January 2—B	Males, 355.8
Males, 396.3	June 3—C	Males, 428.7
Males, 181.8	June 17—D	Males, 191.9
Females, 54.8	November 13—A	Females, 57.2
Females, 219.9	December 4—B	Females, 310.2

3. OESTRUS CYCLE

On February 25, 1937, observations on vaginal smears were started in Experiments A and B. Some of the females were with litters, but observations were commenced on them as soon as the litters were weaned. It was planned to obtain pituitary material for survey of cytological changes from these females and from those of Experiment C (vaginal smears started April 14, 1937); therefore cycles were obtained only between litters in Experiments A and B and before the first litters in the females of Experiment D. The dates of oestrus for each female have been carefully charted and the days between each period noted. Table V shows the number of periods between cycles for each female of each experiment and the number of periods of four[4] days in each case. The average number of periods and the percentage of four-day periods is shown for each experiment and a summary is made of the three experiments.

CONCLUSION. With the controls showing 16.87 percent more four-day cycles than the experimentals, it appears that nicotine in the system interfered with the regular rhythm of the oestrus cycle.

4. Long, 1919 (9), and Long and Evans, 1922 (10), give approximately five days as the normal oestrus cycle, but the strain of rats used in this experiment show such a predominance of four-day cycles in the controls that this period is used as basic. Papanicolau (11) indicates that strains may vary.

TABLE V—OESTRUS CYCLES

EXPERIMENT A

Experimentals Female.	Cycles.	4-Day.	Controls Female.	Cycles.	4-Day.
B	7	1	A	1	1
C	1	0	B	7	0
E	3	0	C	0	0
F	1	1	D	5	2
			E	0	0
			G	3	3
4	12	2	6	16	6
Average	3	0.5		2.66	1
16.6%—4 day.			37.5%—4 day.		

EXPERIMENT B

Female.	Cycles.	4-Day.	Female.	Cycles.	4-Day.
A	3	1	A	9	2
B	4	0	B	3	1
C	13	3	C	2	2
D	1	0	D	9	0
E	7	4	E	1	1
			F	1	1
5	28	8	6	25	7
Average	5.6	1.6		4.16	1.16
28.5%—4 day.			28.0%—4 day.		

EXPERIMENT C

Female.	Cycles.	4-Day.	Female.	Cycles.	4-Day.
1	8	5	1	10	6
2	7	1	2	11	9
3	8	5	3	9	5
4	8	2	4	8	1
5	7	1	5	11	5
6	9	5	6	8	7
6	47	19	6	57	33
Average	7.83	3.16		9.5	5.5
37.8%—4 day.			57.8%—4 day.		

SUMMARY

Experimentals Female.	Cycles.	4-Day.	Experiment	Controls Female.	Cycles.	4-Day.
4	12	2	A	6	16	6
5	28	8	B	6	25	7
6	47	19	C	6	57	33
15	87	29	Totals	18	98	46
	5.8	19.33	Average		5.44	2.55
30.0%—4 day.				46.87%—4 day.		

4. CYTOLOGICAL CHANGES IN THE ANTERIOR PITUITARY GLAND[5]

As the litter mortality under the influence of nicotine seems to rest mainly on the inactivity of the mammary gland and as this gland is considered to be under the guidance of the anterior pituitary, this has been observed for any marked cytological change.

As Charipper and Hatterius (5), as well as Reese (12), show that cell relationships and percentages are influenced by the oestrus cycle, the material was taken at a comparable stage. The time of parturition of each rat was observed as closely as possible and vaginal smears made after forty-eight and before sixty hours had elapsed. Each rat was taken in pro-oestrus.

The method of killing was by chloroform vapor in a closed glass container and the same routine was followed in each dissection. The rat was taken as soon as relaxed and the abdomen and thorax opened. The aortic arch and superior vena cava were cut to insure good drainage of the head and an absorbent plug was placed in the thorax to keep the dissection as bloodless as possible. The organs were taken in the following sequence: Ovaries, vagina, uterus and horns; mammary gland (lower left); spleen and pancreas; kidney and adrenal (left); thryoid; pituitary, the whole gland and a portion of the adjoining brain tissue. The tissues other than the pituitary are reserved for further observation on the influence of nicotine.

The anterior pituitary glands were prepared by the dioxane method of Guyer and sectioned at 4 to 6 micra., Severinghaus (13) technique was used for the staining and Severinghaus (14) was used as a basis of cell differentiation.

In counting the cells, five areas were taken at representative and comparable places in every fifth section. The whole gland was surveyed. The percentages of each type of cell to the whole number counted were then figured with the following results.[6]

FEMALES

	Number of cells counted	Percent acidophils	Percent basophils	Percent chromophobes
Control	10987	33.27	14.18	52.54
Experimentals	9360	27.74	15.9	56.34

MALES

	Number of cells counted	Percent acidophils	Percent basophils	Percent chromophobes
Control	10433	31.88	15.25	52.85
Experimentals	10610	32.84	17.75	51.28

CONCLUSION. In females, the basophils and chromophobes are increased, the acidophils decreased; in males, the basophils and acidophils are increased and the chromophobes decreased under the influence of nicotine.

Brooks (3) shows in females a decrease in acidophils and an increase in basophils and no perceptible change in chromophobes; in males, no perceptible change.

---

5. W. Glen Moss, an assistant in the department, deserves full credit for preparing the slides and making the cell counts.

6. This includes eight specimens of Experiment D: Two glands of the female control, two glands of the female experimental, and two glands each for males. This portion of the work is being continued and further data will be presented at a later date.

ACKNOWLEDGMENTS

We wish to express our thanks and appreciation to Mr. Vernette Mueller for his care and patience in the care and feeding of the animals and his meticulous work in the weighing of the animals and in the administration of the nicotine; to Dr. Charles E. Lane, University of Wichita, for his expert advice and encouragement, especially in connection with the cytological changes in the pituitary gland; and to the Research Committee of the Kansas Academy of Science, through whose consideration we received an award which furthered the work.

LITERATURE CITED

1. BEHREND, ALLEN, and C. H. THIENES. Chronic Nicotinism in Young Rats and Rabbits. Effect on Growth and Oestrus. Jour. Pharmacol. & Exp. Therap. 46 (1):113-124. 1932.
2. BRANCH, HAZEL E. Effects of Alcohol on the Reproductive Powers of Rats (Albino). Trans. Kans. Acad. Sc. 34:311-313. 1931.
3. BROOKS, WILLIAM GERALD. Results of Nicotine Feeding upon the Anterior Pituitary Gland of an Albino Rat. Unpublished manuscript. University of Wichita. 1936.
4. BUEL, F., W. BUEL, F. FIELDING, D. LITTLE, M. LITTLE, C. H. THIENES. Estrus and Reproduction in the White Rat as Influenced by Chronic Nicotinism. Jour. Pharmacol. & Exp. Therap. 60:100. 1937.
5. CHARIPPER, H. A., and H. O. HATTERIUS. Histology of the Anterior Pituitary of the Albino Rat in Relation to Oestrus Cycle. Anat. Rec. 54: 15-25. 1932.
6. DONALDSON, HENRY H. The Rat. Data and Reference Tables. Memoirs of Wistar Institute, No. 6. 1924.
7. GREENE, EUNICE CHACE. Anatomy of the Rat. Trans. Amer. Phil. Soc. 27. 1935.
8. GREENMAN, MILTON JAY, and F. LOUISE DUHRING. Breeding and Care of the Albino Rat. Wistar Inst. of Anat. 1923.
9. LONG, J. A. The Oestrus Cycle in Rats. Anat. Rec. 15:352. 1919.
10. LONG, J. A., and H. M. EVANS. The Oestrus Cycle in the Rat and Associated Phenomena. Memoirs, Univ. of California. 6. 1922.
11. PAPANICOLAU, GEORGE N. Oestrus in Mammals from the Comparative Point of View. Amer. Jour. of Anat. 32:293. 1923.
12. REESE, JOHN D. Anterior Hypophysis of the Rat During the Oestrus Cycle. Anat. Rec. Vol. 52 (Suppl.). 1932.
13. SEVERINGHAUS, AURA EDWARD. A Cytological Technique of the Study of the Anterior Lobe of the Hypophysis. Anat. Rec. 53. 1932.
14. SEVERINGHAUS, AURA E. A Cytological Study of the Anterior Pituitary of the Rat with Special Reference to the Golgi Apparatus and to Cell Relationship. Anat. Rec. Vol. 57:149-175. 1933.

The Frogs and Toads of the Southeastern United States

CHARLES E. BURT, Southwestern College, Winfield, Kan.

This is the second contribution to the knowledge of the amphibians and reptiles of the southeastern United States resulting from a coöperative agreement with the Smithsonian Institution. The work was begun during the summer of 1932 and continued through three additional summers, through the kindness of Dr. Alexander Wetmore, assistant secretary, and Dr. Leonhard Stejneger, head curator of the United States National Museum. Introductory remarks, acknowledgments, and a list of collectors, were given in the previous paper (1938). The accompanying illustrations were prepared by Mr. Paul Boles and Mr. Robert Boles.

The states covered by this paper are Florida, Georgia, Alabama, Mississippi, Tennessee, North Carolina and South Carolina. Thirty-four kinds of frogs and toads occur in the Southeast, and these appear to be diagnosed best by the characters used in the following key.

Key to the Frogs and Toads of the Southeastern United States

1. Frogs and narrow-mouthed toads with neither parotid glands nor a conspicuous black or dark-brown edged horny cutting disc or "spade" on the hind foot at the base of the inner toe 8

1. Toads with parotid glands more or less developed on dorsal surface behind eyes; forms with rounded and indistinct parotid glands always with a conspicuous black or dark-brown edged cutting disc on the hind foot 2

2. Cranial crests (horny ridges) present on head, between and back of eyes; warts numerous; common toads 4

2. No cranial crests; skin relatively smooth; spadefoot toads 3

3. Back dull colored, or with obscure light streaks only. Coastal Plain and inland river valleys, Massachusetts to Texas. Solitary spadefoot toad. 2. *Scaphiopus holbrookii holbrookii*, p. 335

3. Irregular light dorsolateral streaks on back (on each side of wide, dark vertebral band) usually discernable (a poorly differentiated form). Florida Keys. Key West Spadefoot toad .... 1. *Scaphiopus holbrookii albus*, p. 335

4. Body over 38 mm. long 6

4. Body under 38 mm. long 5

5. Two or more pairs of rather symmetrically arranged dark spots on mid-region of back, these more or less in contact proximally with a vertebral light line; warts small and numerous, usually over five warts in the largest black blotches on back. Coastal Plain, Carolinas to Louisiana. Oak toad....5. *Bufo quercicus*, p. 337

5. Dark spots on back absent or smaller, not so close to vertebral light line (if one is present); usually five or less than five warts in largest black blotches on back.. 6

6. Parotid gland not usually in contact with the transverse postorbital ridge or crest, but more or less connected with this ridge by an outer longitudinal bar; back less warty, often one wart to the largest dark spots 7

6. Parotid gland usually in contact with the transverse postorbital ridge; back more warty, often with two to five warts to the largest dark spots. All southeastern states above the Coastal Plain, not in peninsular Florida. Fowler's toad. 6. *Bufo woodhousii fowleri*, p. 338

7. Longitudinal cranial crests (in interocular area) with posterior knobs or sharp elevations immediately opposite postocular area. Southeastern states in the Coastal Plain, Carolinas to Louisiana. Southern toad.. 4. *Bufo americanus terrestris*, p. 336

7. Longitudinal cranial crests without noticeable posterior knobs or elevations. Southeastern states, above the Fall Line. American toad. 3. *Bufo americanus americanus*, p. 335

8. Digits on front feet not expanded at tips.......... 21
8. Digits on front feet noticeably dilated at tips.......... 9
9. Digital dilations on front feet large, wide, conspicuous, more or less flattened on under side to make pads for climbing or clinging; fingers short in most species, usually not giving impression of special weakness; tree frog types.......... 10
9. Digital dilations on front feet usually slight in width; or if expanded moderately, then toes of all feet comparatively long and slender, often giving impression of special weakness; chorus frog types.......... 21
10. Skin of back not warty *or* with very fine granules only; conspicuous granules and warts absent.......... 16
10. Skin of back noticeably warty, often with numerous small warts, but sometimes with sparse warts that tend to be larger and frequently dark pigmented.......... 11
11. Skin of top of head loose in region between eyes.......... 13
11. Skin of top of head attached to skull, especially in a definitely outlined prefrontal depression; Florida only.......... 12
12. A more or less definitely outlined dark bar between eye and nostril; adults under 50 mm. from snout to anus; ground color of snout and lighter areas on body usually reddish, pinkish or tan. Florida. Pink-snouted frog. 23. *Eleutherodactylus ricordii,* p. 349
12. No dark bar between eye and nostril; adults over 50 mm. long; ground color sometimes with tan, but usually purple, green or gray. Southern Florida. Giant tree frog.......... 20. *Hyla septentrionalis,* p. 347
13. Rear of thigh usually distinctly spotted *or* more or less reticulated with dark and light; size smaller, body length usually under 55 mm.......... 14
13. Rear of thigh usually unspotted, often white or purplish; size larger, old adults often over 55 mm. long, younger specimens less. Coastal Plain, Carolinas to Louisiana. Barking tree frog.......... 19. *Hyla gratiosa,* p. 346
14. Rear of thigh more or less reticulated with dark and light but not with distinct, isolated yellow spots; size larger, adults frequently (but by no means always) over 40 mm. long.......... 15
14. Rear of thigh with conspicuous yellow spots on darker background; average size smaller.......... 16
15. Voice a loud penetrating trill; rear of thigh with deep yellow or orange in life, its dark markings usually definitely reticulated or netted. All southeastern areas, except peninsular Florida. Common tree frog.. 22. *Hyla versicolor versicolor,* p. 348
15. Voice a birdlike whistle; rear of thigh a pale yellowish-green in life, its dark markings fainter and usually not definitely reticulated. A relatively rare species, morphologically very close to above; in case of doubt with preserved material most examples would be expected to be the former. Southeastern United States. Bird-voiced tree frog.......... 15. *Hyla avivoca,* p. 344
16. Rear of thigh lightly dotted, unspotted, white, uniform dark, or lined.......... 18
16. Rear of thigh usually heavily mottled with dark and light or with prominent spots, 17
17. Rear of thigh with prominent orange or yellow spots. Coastal Plain, Carolinas to Texas. Pine woods tree frog.......... 18. *Hyla femoralis,* p. 346
17. Rear of thigh mottled or speckled.......... 34
18. Back without median markings, or with scattered dark spots or reticulations; ground color variable, usually green or brown.......... 19
18. Back with a dark X-shaped cross (sometimes of imperfect design) which traverses the vertebral line; ground color usually tan or light brown. All southeastern states. Spring peeper.......... 17. *Hyla crucifera,* p. 345
19. Back uniform green above in life; a dark, wide, walnut-colored band extending obliquely backward from eye through tympanum, this bordered on each side by a more or less distinct white line. Atlantic Coastal Plain. Anderson's tree frog. 14. *Hyla andersonii,* p. 344
19. Back sometimes with contrasted markings, such as spots, not exactly as above.... 20
20. Size rarely over 35 mm.; lateral light line more or less indistinct on body when skin is pulled flat; femur and tibia almost as long as or longer than body; color spotted to uniform above. Swamps of the Coastal Plain, Virginia to Texas, inland in the Mississippi River Basin. Swamp tree frog... 21. *Hyla squirella,* p. 347
20. Adults over 35 mm.; lateral light line usually distinct on body; femur and tibia not as long as body; color usually uniform above. All southeastern states. Green tree frog.......... 16. *Hyla cinerea cinerea,* p. 344

21. Webs not developed on toes of hind feet, or very inconspicuous.............. 34
21. Webs well developed on toes of hind feet, conspicuous....................... 22
22. Tympanum very distinct; size larger, adults over 40 mm. long (snout to anus), young smaller. Common frogs (*Rana*).................................. 23
22. Tympanum not well defined, even though more or less evident; size smaller, adults usually less than 30 mm. long. All southeastern states. Common cricket frog. 7. *Acris gryllus*, p. 340
23. A dorsolateral skin fold, *or* both a conspicuous white dorsolateral stripe *and* large rounded dark spots, present on each side; skin folds, when present, straight, narrow to broad, extending at least from level of the eye to well past shoulder, 29
23. No continuous dorsolateral skin fold and no large rounded dark spots on each side, at least not far posterior to shoulder; skin folds, when present, short, multiple, irregular or curved.. 24
24. Last joint of middle digit of hind foot rather blunt, more or less rounded at tip; back uniformly brown or greenish, or covered with irregular dark markings, longitidunal light stripes absent; adults large (over three inches), young smaller. Bullfrogs 25
24. Last joint of middle digit of hind foot weaker, drawn to a relatively fine point at tip; back in front of hind legs with at least the suggestion of a pair of yellow dorsolateral stripes (often obscure); adults smaller, usually not over three inches. Eastern Coastal Plain, New Jersey to peninsular Florida. Carpenter frog. 33. *Rana virgatipes*, p. 356
25. Ground color of snout and lips dark brown, mousy gray or blackish.......... 27
25. Ground color of snout and lips light gray, light brown or greenish.............. 26
26. Second toe of hind foot usually less than 54 percent as long as fourth toe; color variable, with mottling of chest and throat frequently of about the same general intensity as that on under surface of thighs; free margin of web usually extending only to base of terminal joint of middle digit of hind foot, but sometimes extending beyond; largest adults over six and one-half inches. All southeastern states, both in and above Coastal Plain. Common bullfrog. 26. *Rana catesbeiana*, p. 350
26. Second toe of hind foot usually over 54 percent as long as fourth toe; color of chest and throat usually white or light slate, in rather sharp contrast to a greater or lesser development of dark mottlings on under surface of thighs; free margin of web usually extending past base of last joint of middle digit of hind foot; largest adults not over six and one-half inchces. Gulf Coastal Plain, Florida and southern Georgia to Louisiana. Southern bullfrog......... 28. *Rana grylio*, p. 352
27. Entire ventral surface heavily mottled, suffused, or marbled with chocolate, dark brown, or black (not slate or gray) on a lighter background................ 28
27. Under surfaces largely white or mottled with slate or gray, especially about the chin and hind legs. All southeastern states, both in and above Coastal Plain. Common bullfrog .... 26. *Rana catesbeiana*, p. 350
28. A definite black blotch usually present in front of insertion of forearm; comparatively warty on body, upper eyelid and center of tympanum; warts of back sometimes forming conspicuous welts or striations. Coastal Plain, South Carolina to Mississippi. River-swamp bullfrog...................... 29. *Rana heckscheri*, p. 353
28. Color pattern variable, usually no definite blotch in front of insertion of forearm; body smooth to warty, warts often small and numerous, not as conspicuous as in above species even when perfectly evident. All southeastern states, both in and above Coastal Plain. Common bullfrog, darker phases. 26. *Rana catesbeiana*, p. 350
29. Back brown or olivaceous, unspotted, or with comparatively small and irregular markings above dorsolateral area; spots, if present, not usually subovoid or bordered by white 33
29. Back usually grayish or slaty tan; dark dorsal spots more or less separated, conspicuous, often (but not always) bordered by white; spotted frogs.......... 30
30. Dorsal spots irregular, not *definitely* in two well aligned longitudinal rows of squarish spots (between the dorsolateral skin folds); thighs with no deep yellow or orange in life 31
30. Dorsal spots more or less irregular, predominantly in two longitudinal rows of squarish spots; thighs with bright yellow or orange in living adults. Southeastern states above the Fall Line. Pickerel frog.................... 30. *Rana palustris*, p. 353

31. Dorsolateral folds not flecked or spotted, usually decidedly lighter than ground color of back; pattern of back relatively coarse and distinct. All southeastern states. Leopard frog .... 31. *Rana pipiens*, p. 353
31. Dorsolateral folds usually flecked or spotted and frequently of about the same color as body, dark; pattern of back relatively fine with a striking network of dark and light 32
32. Dorsal dark spots irregular in shape and variable in size, sometimes small and numerous, inconspicuously outlined with a white border or having none at all. Atlantic Coastal Plain. Carolinas to Florida. Gopher Frog........ 25. *Rana capito*, p. 349
32. Dorsal dark spots more or less rounded, usually large, conspicuously outlined with white. Mississippi Valley and the Gulf Coast. Crawfish frog. 24. *Rana areolata*, p. 349
33. Snout green and black in life; side of face uniform in color or irregularly marked with darker. All southeastern states, exclusive of peninsular Florida. Green frog... 27. *Rana clamitans*, p. 351
33. Snout usually tan in life; side of face from snout to tympanum with a prominent dark mask; black spots common on dorsolateral fold. Above the Fall Line, Carolinas north and westward. Wood frog............. 32. *Rana sylvatica*, p. 356
34. Snout not sharply pointed or narrowed; mouth wide as in most amphibians; back often striped or spotted, frequently with black or greenish dorsal markings. False cricket frogs or chorus frogs (*Pseudacris*)............................ 35
34. Snout very pointed; mouth narrow; back often unicolor or with irregular dark markings, predominant coloration brown above. All southeastern states. Eastern narrow-mouthed toad......................... 34. *Microhyla carolinensis*, p. 356
35. Posterior third of back usually with approximately as many dark markings as the anterior part (except laterally), seldom entirely devoid of dark streaks or spots; adults larger, over 18 mm. long.................................... 36
35. Posterior third of back usually without dark markings, especially dorsally; adults small, rarely over 18 mm. long. Coastal Plain, Carolinas to Texas. Little chorus frog.................................... 12. *Pseudacris ocularis*, p. 343
36. Back normally with rather straight-edged to somewhat wavy, dark, confluent, longitudinal dark bands and light lines; body predominantly striped............ 39
36. Back normally spotted *or* with irregular or oblique dark markings on a lighter ground color; body not predominantly striped, but spots sometimes more or less longitudinally confluent 37
37. Dark markings usually circular in outline, frequently forming longitudinal series; size smaller, adults usually under 25 mm. long.......................... 38
37. Dark markings irregular in shape and sometimes confined to sides or even absent, usually not circular or ovoid, but forming irregular or oblique series when present in abundance; size larger, adults usually over 35 mm. long, young less. Coastal Plain, Carolinas to Louisiana. Ornate chorus frog.... 13. *Pseudacris ornata*, p. 343
38. Light maxillary stripe confluent or continuous below eye, not much reduced or broken. Coastal Plain, Carolinas to Louisiana, exclusive of peninsular Florida. Swamp chorus frog............................... 9. *Pseudacris nigrita nigrita*, p. 342
38. Light maxillary stripe broken, irregular, much reduced, or absent below eye; upper lip dark, spotted, or with several oblique light lines, but not largely white. Peninsular Florida. Florida chorus frog.... 10. *Pseudacris nigrita verrucosa*, p. 343
39. Dorsal dark markings usually of about the same intensity as lateral ones, dark stripes frequently prominent and wide; skin usually rougher, less delicate, although often not especially warty. Southeastern states above the Fall Line. Striped chorus frog .... 10. *Pseudacris nigrita triseriata*, p. 342
39. Dorsal dark markings relatively pale as compared with anterolateral ones, except perhaps for small flecks at edges of the broad vertebral band; skin more delicate. Coastal Plain from Virginia to Georgia. Carolina chorus frog. *Pseudacris brimleyi* Brandt and Walker, p. 341

LIST OF SPECIES

1. *Scaphiopus holbrookii albus* Garman

This spadefoot toad has been described from the keys off the southern tip of Florida. It is uncommon in collections. One specimen (U. S. N. M. No. 85472) was secured on Key West, Monroe county, in 1932, by M. K. Brady. As indicated by Wright and Wright (1933), *albus* appears to be a poorly differentiated race and it may be impossible to maintain its identity when more adult specimens become available for comparison. U. S. N. M. No. 61655 from Hillsborough county, Fla., listed here under *holbrookii*, is almost identical in appearance to the example from Key West, the dorsolateral light streaks being only slightly less diffused.

2. *Scaphiopus holbrookii holbrookii* (Harlan)

This is the common solitary spadefoot toad of the Southeast. As indicated above, it occurs on the Florida mainland, where its characters tend to approach those of the insular *albus*. The species is most abundant in damp, swampy areas. An unusually melanistic series of seven specimens from Columbus county, North Carolina, shows the dorsolateral light streaks varying from obscure to absent. The ground color of the back of *holbrookii* varies from black through purplish brown and light brown to gray, with or without reticulations, marblings or spots. The under parts are yellow or white.

ALABAMA. *Mobile:* Mobile (Hurter, July 4, 1910).

FLORIDA. *Brevard:* Georgiana (Wittfield). *Dade:* Beuna Vista near Miami (Brown, 1929). *Hillsborough:* Seven Oaks (Howell, June, 1918). *Marion:* Silver Springs (Allen, November 15, 1936). Literature: Alachua, Baker, Nassau and Orange counties.

GEORGIA. *Berrien:* Nashville (Taylor). *Glynn:* St. Simons Isle (Pastell). Literature: Baldwin, Charlton, Liberty and Ware counties.

MISSISSIPPI. Literature: Harrison county.

NORTH CAROLINA. *Columbus:* Lake Waccamaw (Gray, July 3, 1933). *Henderson:* Bowman's Bluff (Holmes, April 5, 1897). *Transylvania:* Brevard (Paine, July, 1911). Literature: Beaufort, Carteret, Greene, Nash, Pitt, Wake and Wilson counties.

SOUTH CAROLINA. *Horry:* Conway, and 2 mi. SE Conway (Burt, July 23, 1933). Literature: Charleston and Richland counties.

3. *Bufo americanus americanus* Holbrook

According to the criteria advanced by Kellogg (1932) the American toad has the parotid glands moved posteriorly from the postorbital ridge, so that a space is left between the two elements. Because of this, there is a greater development or prolongation of the external supratympanic ridge or crest, as compared with the condition in the toad known as *fowleri*. While some toads seem to be intermediate between *americanus* and *fowleri* (and hybridization may occur in various localities), no geographical consistency of the type of intergradation that is indicative of subspecies appears to exist. This is contrary to the data obtained by a comparison of *americanus* and *terrestris*, as indicated below under the latter form.

ALABAMA. *Madison:* Paint Rock river 2 mi. SE Paint Rock (Burt, August 3, 1933). *Marshall:* New Hope on bank of Paint Rock river (Burt, August 3, 1933). Literature: Jackson county.

GEORGIA. Literature: Union and Lumpkin counties in the northwestern mountains (Harper, 1935).

MISSISSIPPI. *Lawrence:* Monticello (Tennison). *Winston:* Noxpater (Burt, June 14, 1934).

NORTH CAROLINA. *Burke:* Bridgewater (Burt, July 31, 1933). *Macon:* above Highland Falls on Whiteside Mt. near Highlands; and Lindenwood Lake near the Biological Station at Highlands (Burt, July 9, 1932). *Swain:* Smokemont (Burt, June 8, 1932). *Wayne:* Goldsboro (U. S. N. M., No. 8340). Literature: Ashe, Avery, Buncombe and Transylvania counties.

SOUTH CAROLINA. *Anderson:* Anderson (Daniel). Literature: Abbeville and Richland counties.

TENNESSEE. *Carter:* Doe River marshes on Roan Mt. (Reid, 1930). *Cumberland:* Isoline (Burt, July 25, 1932). *Henderson:* 10 mi. E Lexington (Burt, July 27, 1932). *Humphries:* Waverly (Burt, April 14, 1936). *Perry:* Linden (Burt, July 27, 1932). *Roane:* Kingston (Burt, July 27, 1932). *Smith:* Dixon Springs (Burt, July 24, 1932). *Whitley:* Pleasant View (Burt, July 11, 1932). Literature: Davidson, Hamilton, Obion, Sevier and Sumner counties.

4. *Bufo americanus terrestris* Bonnaterre

Using the criteria given in the key and under *americanus* for the separation of that form from *fowleri,* the southern toad is like *americanus* in the relation of the parotid gland to the postorbital ridge or bar, a greater or lesser space being developed between these two elements. In addition to this a distinct elevation or knob is found on each side extending backward from the point where the interorbital crest meets the postorbital crest at approximately right angles. The external supratympanic bar usually extends backward from the postorbital crest at the end opposite the knob just mentioned. These features are best shown by large adults. Young toads of all of the above mentioned forms lack well developed diagnostic features, in fact; for it takes some time after metamorphosis from the tadpole stage before the cranial crests appear from obscure primordia.

In the areas just above the Fall Line the ranges of *americanus* and *terrestris* meet and their characters intergrade, the cranial knobs being greatly varied in development but roughly intermediate in nature. This is seen in Mississippi and Alabama. Harper (1935) has noted it in North Carolina, and I have described it from Arkansas (1935). Even specimens from Tennessee and other northern points in the more typical range of *americanus* may occasionally develop cranial knobs suggestive of *terrestris* (as in a specimen from Humphries county); and vice versa (*terrestris* with low cranial crests from Hancock county, Mississippi). As a subspecies in the Southeast, *americanus* occurs in the Coastal Plain and *terrestris* ranges below the Fall Line. The latter appears to be most strongly differentiated, and also most abundant, in southern Georgia and all of Florida.

ALABAMA. *Dale:* Ariton (Burt, July 1, 1933). *Greene:* Eutaw (Winchell, 1853). *Mobile:* Spring Hill (Benedict, July 10, 1932). *Montgomery:* Barachias (Holt, July 24, 1917). Literature: Baldwin, Pike and Sumter counties.

FLORIDA. *Brevard:* Titusville (Green, April 11, 1889). *Broward:* Ft. Lauderdale (Brady, February 23, 1932). *Dade:* Coconut Grove (Rogers, December, 1924); Lee Hammock (Brady, January 20, 1932); Miami (Brady, February 17, 1932). *Escambia:* Pensacola (Hammond). *Hillsborough:* General report (Hurter, June 15, 1910). *Lake:* Esmeralda (Brown, February 25, 1923); Eustis (Holm, February 27, 1892). *Levy:* General report (Hurter, 1891). *Palm Beach:* Jupiter (Howell, March 15, 1918). *Polk:* Auburndale (Wood, March, 1912); Lake Arbuckle (Palmer, March, 1895). *Santa Rosa:* Milton (Walker, May 23, 1881). *Seminole:* Lake Monroe (Baird); Sanford (Stoner, November, 1928). *Suwanee:* Branford (Ball, 1929). Literature: Alachua, Baker, Duval, Gadsden, Nassau, Orange, Osceola and Sarasota counties.

GEORGIA. *Baldwin:* Milledgeville (Kumlein and Bean, June 4, 1875). *Brantley:* Hoboken (Burt, July 22, 1933). *Chatham:* Savannah (Fisher, 1886). *Clinch:* Homerville (Burt, July 21, 1933). *Houston:* 13 mi. N Perry (Burt, July 21, 1933). *Liberty:* Riceboro (Burt, July 22, 1933). *McIntosh:* Darien (Burt, July 22, 1933); Eulonia (Burt, July 22, 1933). *Ware:* Manor (Burt, July 21, 1933). Literature: Bacon, Berrien, Camden, Charlton, Columbia, Jefferson, Lowndes, Randolph, Richmond, Shelby, Tattnall and Toombs counties.

MISSISSIPPI. *Greene:* Piave (Burt, June 30, 1934). *Hancock:* Bay St. Louis (Allison, July 31, 1902). *Hinds:* 8 mi. SW Jackson (Burt, June 25, 1934). *Jackson:* Orange Grove (Burt, August 6, 1933). *Madison:* Pearl river 9 mi. SE Canton (Burt, June 28, 1934). *Pontotoc:* Gershorm (Burt, June 12, 1934). *Warren:* Vicksburg (Viosca). *Washington:* General report (U. S. N. M.). *Winston:* Noxpater (Burt, June 14, 1934). Literature: Harrison, Lafayette and Lauderdale counties.

NORTH CAROLINA. Beaufort: 14 mi. N Washington (Burt, July 24, 1933). *Bladen:* White Lake (Chitwood, July 5, 1930). *Columbus:* Lake Waccamaw (Gray, July 3, 1933). Literature: Buncombe, Chatham, Chowan, Craven, Cumberland, Greene, Jones, Nash, New Hanover, Onslow, Pamlico, Pitt, Scotland, Washington and Wilson counties.

SOUTH CAROLINA. *Anderson:* Anderson (Paine). *Berkeley:* Oakley (Hayward). *Colleton:* Hendersonville (Burt, July 23, 1933). *Horry:* Conway (Burt, July 23, 1933). *Lexington:* Brookland (Burt, June 27, 1933). Literature: Aiken, Beaufort, Charleston, Georgetown, Greenville and Richland counties.

5. *Bufo quercicus* (Holbrook)

As an adult the oak toad is the smallest *Bufo* in the United States. It has a more or less distinct light vertebral line; and the body, which may or may not be mottled, is brown or gray, with the under surface yellow, usually with dark flecks. My remark (1932) that this species is an arboreal species was inadvertent and it has been properly questioned by Harper (1935). The oak toad is a ground inhabiting form, hiding away during dry periods, but appearing in abundance along the coast after heavy rains. An interesting popular account of the species was given by Harper (1931).

ALABAMA. *Autauga:* Autaugaville (Howell, April 16, 1912). Literature: Baldwin, Mobile and Washington counties.

FLORIDA. *Columbia:* Benton (Ball, 1929). *Dade:* Paradise Key (Brady, January 20, 1932). *Lake:* Eustis (U. S. Dept. Agri.). *Lee:* Fort Myers (Hurter, June 20, 1910). *Levy:* General report (Hurter, 1891). *Marion:* McIntosh (Ball, 1929). *Monroe:* Big Pine Key (Brady, 1932). *Polk:* Auburndale (Wood, March, 1912); Lake Arbuckle (Palmer, 1895). *Volusia:* Ponce Park (Bean, November 24, 1908). Literature: Alachua, Clay, Duval, Hillsborough, Nassau, Orange, Osceola, Pinellas, St. Johns, Santa Rosa and Sarasota counties.

GEORGIA. *Bryan:* 10 mi. S Roding (Burt, July 22, 1933). *Chatham:* 10 mi. SW Savannah (Burt, July 22, 1933). *Clinch:* Homerville (Burt, July 21, 1933). *Dooly:* Vienna (Burt, July 21, 1933). *Emanuel:* Summit (Benedict, July 5, 1932). *Glynn:* Brunswick (Burt, July 22, 1933). *Liberty:* Riceboro (Burt, July 22, 1933). *McIntosh:* 10 mi. N Eulonia (Burt, July 22, 1933). *Ware:* Manor, and Waycross (Burt, July 21, 1933). Literature: Bacon, Camden, Charlton, Pierce and Wayne counties.

NORTH CAROLINA. *Beaufort:* Washington (Gray, July 1, 1933). *Columbus:* Lake Waccamaw (Gray, July 3, 1933). *Jones:* Polloksville (Burt, July 24, 1933). Literature: Brunswick, Carteret, Craven, Columbus, Duplin, Edgecombe, Lenoir, New Hanover and Robeson counties.

SOUTH CAROLINA. Literature: Charleston, Richland and Richmond counties.

6. *Bufo woodhousii fowleri* Hinckley

The status of Fowler's toad is in doubt. In 1935 I considered *woodhousii* and *fowleri* to be synonymous, based largely on a comparison of specimens from the Middle West, including Arkansas, Louisiana, Texas, and Kansas. The two populations still appear to me to be very closely allied, if not identical, and I feel that they are no more distinct than subspecies at best, thus agreeing with Smith (1934). The eastern *fowleri* averages darker in color, tends to have dark ventral flecks more often, and appears to be a little less warty. These are extremely poor diagnostic characters even for use in describing a modern subspecies. They fail repeatedly when careful comparisons are made and it is hoped that if *fowleri* is to be given future recognition that better distinctions will be found. Until the two supposed variants can be identified by more definite criteria, the ranges must be fixed by purely arbitrary means. In this way I follow custom in naming these toads *fowleri* throughout the entire Southeast. The two U. S. N. M. cotypes of *B. lentiginosus pachycephalus* have been examined and they are typical *fowleri*.

This is a very common toad in the Southeast, frequently occurring in the highlands practically to the exclusion of *americanus* and *terrestris*, even in large populations. Amplexus was observed in McCormick county, South Carolina, on July 13, 1933, at the edge of a shallow pond in a wooded area two days after a big rain. Various salientians, including these toads, were in full chorus.

ALABAMA. *Conecuh:* Evergreen (U. S. Fish. Comm., May, 1889). *DeKalb:* Chavies (Burt, July 8, 1933). *Greene:* Eutaw (Winchell). *Jefferson:* Pinson (Burt, July 10, 1933). *Lauderdale:* Center Star (Burt, July 9, 1933). *Lime-*

stone: Athens (Burt, July 8, 1933). *Marion:* 10 mi. NW Hamilton (Burt, July 9, 1933). *Shelby:* Helena (U. S. Fish. Comm., May, 1889). *St. Clair:* Ashville (Burt, July 10, 1933). *Wilcox:* Between Bethel and Pine Hill (Godbold, October 11, 1919). Literature: Calhoun, Mobile, Montgomery and Tuscaloosa counties.

GEORGIA. *Baldwin:* Milledgeville (Kumlein and Bean, June 4, 1876). *Barrow:* Stratham, and Winder (Burt, July 3, 1933). *Bartow:* Cass Station (Burt, July 11, 1933). *Chattooga:* Trion (Burt, July 8, 1933). *Cherokee:* Woodstock (Burt, July 11, 1933). *Cobb:* Kennesaw (Burt, July 11, 1933). *DeKalb:* Chamlee (Burt, July 12, 1933). *Floyd:* Rome (Burt, July 11, 1933). *Forsyth:* Cumming (Burt, June 30, 1933). *Gordon:* Fair Mount (Burt, July 7, 1933). *Greene:* Greensboro (Burt, July 19, 1933). *Gwinnett:* Duluth, and at Norcross (Burt, July 20, 1933). *Hall:* Between Belton and Lulu (Burt, June 29, 1933). *Jackson:* Thompson's Mill (Allard, March 28, 1908). *Lincoln:* Island above Price Island in Savannah river (Burt, July 19, 1933). *Morgan:* Smyrna (Burt, July 19, 1933). *Oconee:* Bishop (Burt, July 19, 1933). *Pickens:* Jerusalem (Burt, July 7, 1933). *Rabun:* Mountain City (Burt, July 2, 1933); Burton Lake (Burt, July 3, 1933); 9 mi. W north tip of Burton Reservoir (Burt, July 1, 1933). *Spalding:* Orchard Hill (Burt, July 20, 1933). *Warren:* Camak (Kumlein and Bean, June, 1876). Literature: Columbia, Fannin, Habersham, Jackson, Murray, Oglethorpe, Randolph, Richmond and Townes counties.

MISSISSIPPI. *Calhoun:* Derma (Burt, June 13, 1934). *Chickasaw:* Houston (Burt, June 12, 1934). *Franklin:* McCall Creek (Burt, June 15, 1934). *Jefferson Davis:* Prentiss, and Silver Creek (Burt, June 14, 1934). *Lawrence:* Silver Creek (Burt, June 14, 1934). *Lincoln:* Brookhaven (Burt, June 15, 1934). *Noxubee:* Mashulaville (Burt, June 30, 1934). Literature: Harrison county.

NORTH CAROLINA. *Bertie:* Windsor (Burt, July 24, 1933). *Buncombe:* Bent Creek Forest Exp. Station, Asheville (Gray, June 3, 1933). *Cheatham:* Bynum (Burt, June 26, 1933). *Cherokee:* Ranger (Burt, June 6, 1932). *Chowan:* Edenton (Metcalf and Ewing, 1929). *Dare:* Hatteras, Hatteras Island (Kellogg and Poole, May 25, 1927). *Davidson:* Jackson Hill (Burt, July 16, 1933). *Durham:* Durham, and Hope Valley (Burt, July 14, 1933). *Forsyth:* Salem (Lineback). *Jackson:* General report (Fitzgerald). *Jones:* Maysville (Burt, July 24, 1933). *Lenoir:* Kinston (U. S. N. M.). *McDowell:* Nebo (Burt, July 31, 1933). *Montgomery:* Biscoe (Young, July 7, 1932). *Orange:* Chapel Hill (Burt, June 26, 1933); Piney Mt. (Burt, July 14, 1933). *Randolph:* Farmer (Burt, July 17, 1933). *Rowan:* Cleveland (Burt, July 14, 1933). *Swain:* Smokemont (Burt, June 8, 1932). *Union:* Waxhaw (Burt, July 18, 1933). *Wayne:* Goldsboro (Burt, July 7, 1932). Literature: Avery, Beaufort, Cumberland, Scotland, Transylvania and Wake counties.

SOUTH CAROLINA. *Abbeville:* Abbeville (Barrett). *Anderson:* Anderson (Daniel). *Lexington:* Leesville, and at Lexington (Burt, June 27, 1933). *McCormick:* McCormick (Burt, July 13, 1933); Meriwether (Burt, June 28, 1933); Modoc (Burt, July 5, 1933); Parksville (Burt, July 13, 1933). *Saluda:* Murray Lake (Burt, July 5, 1933). Literature: Charleston, Greenville and Richland counties.

TENNESSEE. *Cumberland:* Crossville (Burt, July 25, 1932). *Dickson:* Williamsville (Burt, June 4, 1932). *Fayette:* La Grange, and Oakland (Burt, June 12, 1934). *Fentress:* Grimsley (Burt, July 25, 1932). *Grainger:* Bean Station (Burt, July 21, 1932). *Hamilton:* Ooltewah (Burt, June 6, 1932). *Jefferson:* Jefferson City (Burt, July 22, 1932). *Lauderdale:* Ashport (Burt, July 28, 1932). *Macon:* Willette (Burt, July 19, 1932). *Moore:* Carthage (Burt, July 7, 1932). *Roane:* Kingston (Burt, July 27, 1932). *Smith:* Pleasant Shade (Burt, July 19, 1932); Carthage (July 24, 1932). *Union:* Maynardsville (Burt, July 23, 1932). *White:* Bon Air (Burt, July 23, 1932). Literature: Benton, Dyer, Henry, McMinn, Madison, Obion, Sevier and Shelby counties.

7. *Acris gryllus* (LeConte)

The cricket frog is very common throughout the Southeast, except at the highest levels; and the most favorable habitat appears to be the woodland pond or streamlet. When disturbed, these frogs often seek concealment in algae, muck, leaves, grass or sand. Because of their small size and noticeable wariness at night, they are rather hard to secure in series while at the height of their song. However, in the daytime it is frequently easy to obtain a considerable number, largely because of their relative abundance and their habit of resting in the open.

ALABAMA. *Bibb:* Brent (Burt, August 6, 1933). *Dale:* Ariton (Burt, July 1, 1931). *Marion:* Hamilton (Burt, July 9, 1933). *Perry:* Heilberger (Burt, August 6, 1933). *Wilcox:* Black Bend (Benedict, April 26, 1928). Literature: Marengo, Mobile, Macon, Pike, Washington and Wilcox counties.

FLORIDA. *Broward:* Pompano (Brady, January 2, 1932). *Clay:* Orange Park at Jacksonville (Miller, August 19, 1931). *Dade:* Paradise Key (Brady, January 21, 1932); Pinecrest (Brady, January 31, 1932); Miami (Bartsch, April 21, 1912). *Duval:* Dinsmore (Burt, August 2, 1937). *Escambia:* Pensacola (Hammond). *Hillsborough:* Tampa (Evermann and Kendall, November 3, 1896). *Levy:* Cedar Keys (Miller, March 26, 1926). *Manatee:* Fresh Pond near Myakka river (U. S. Fish. Comm., March 11, 1889). *Putnam:* Welaka (Kendall, March 20, 1897). *Polk:* Lake Arbuckle (Palmer, March, 1895); Auburndale (Wood, April, 1912). *Volusia:* New Smyrna 6 mi. N Biscayne (Bean, December 12, 1905). Literature: Alachua, Jackson, Lake, Leon, Monroe, Nassau and Santa Rosa counties.

GEORGIA. *Bartow:* Cass Station, and Emerson (Burt, July 11, 1933). *Brantley:* Lulaton (Burt, July 22, 1933). *Bryan:* Roding (Burt, July 22, 1933). *Chatham:* Savannah (Fisher, 1886). *Clinch:* Homerville (Burt, July 21, 1933). *Columbia:* Evans (Burt, July 6, 1933). *Forsyth:* Cumming (Burt, June 30, 1933). *Gordon:* Fair Mount (Burt, July 7, 1933). *Gwinnett:* Thompson's Mill (Allard, May, 1910). *Liberty:* Riceboro (Burt, July 22, 1933). *Lowndes:* Valdosta (Burt, July 21, 1933). *McIntosh:* Eulonia (Burt, July 22, 1933). *Richmond:* Augusta (Burt, July 19, 1933). *Turner:* Sycamore (Burt, July 21, 1933). *Walker:* LaFayette (Burt, July 8, 1933). *Ware:* Manor, and Waycross (Burt, July 21, 1933). Literature: Berrien, Camden, Charlton, Cobb, Decatur, Glynn, Hall, Jefferson, Jenkins, Pierce, Randolph and Toombs counties.

MISSISSIPPI. *Amite;* Glading (Burt, July 1, 1934). *Calhoun:* Calhoun City, and Derma (Burt, June 13, 1934). *Chickasaw:* Houston (Burt, June 12, 1934). *Franklin:* McCall Creek (Burt, June 15, 1934). *Greene:* Piave (Burt, June 30, 1934). *Hancock:* Bay St. Louis (Bailey, April, 1892). *Jasper:* Bay Springs (Burt, June 14, 1934). *Jefferson Davis:* Prentiss on Bowie creek (Burt, June 14, 1934). *Lawrence:* Silver Creek (Burt, June 14, 1934). *LeFlore:* Greenwood (Burt, June 29, 1934). *Lincoln:* Brookhaven (Burt, June 15, 1934). *Madison:* Canton (Burt, June 28, 1934). *Newton:* Decatur, and Newton (Burt, June 14, 1934). *Noxubee:* Mashulaville (Burt, June 30, 1934). *Perry:* Beaumont (Burt, July 1, 1934). *Pontotoc:* Pontotoc (Burt, June 12, 1934). *Scott:* Forest (Burt, June 28, 1934): *Wayne:* Clara Chicora (Burt, June 30, 1934). Literature: Harrison, Jackson and Lauderdale counties.

NORTH CAROLINA. *Beaufort:* Washington (Gray, July 1, 1933). *Buncombe:* Bent Creek Exp. Station (Gray, June 3, 1933). *Chowan:* Edenton (Metcalf and Ewing, 1929). *Columbus:* Lake Waccamaw (Gray, July 3, 1933). *Craven:* Havelock (1929). *Hertford:* Ahoskie (Burt, July 24, 1933). *Moore:* Lake View (Burt, June 27, 1933). *Northampton:* Jackson (Burt, July 7, 1932). *Randolph:* Farmer (Burt, July 16, 1933). *Richmond:* Hoffman (Burt, June 27, 1933). *Robeson:* Lumberton (Gray, July 4, 1933). *Union:* 15 mi. N. Monroe (Burt, July 18, 1933). *Washington:* Plymouth (Smith, April 12, 1892). *Wayne:* Goldsboro (Miller). Literature: Camden, Carteret, Durham, Edgecombe, Forsyth, Guilford, Harnett, Johnston, New Hanover, Orange, Sampson, Transylvania and Wake counties.

SOUTH CAROLINA. *Beaufort:* Hardeeville (Burt, July 23, 1933). *Charleston:* Adams Run (Burt, July 23, 1933). *Chesterfield:* Patrick (Burt, June 27, 1933). *Georgetown:* Campfield (Burt, July 23, 1933). *Lexington:* Leesville (Burt, June 27, 1933). *McCormick:* McCormick (Burt, July 13, 1933). Literature: Aiken, Greenville, Marion and Richland counties.

TENNESSEE. *Henderson:* Lexington (Burt, July 27, 1932). *Hickman:* Centerville (Burt, July 27, 1932). *Humphries:* Weaverly (Burt, April 14, 1936). *Jefferson:* Jefferson City (Burt, July 22, 1932). *Knox:* Knoxville (Burt, July 21, 1932). *Perry:* Linden (Burt, July 27, 1932). *Warren:* McMinnville (Burt, July 27, 1932). Literature: Hamilton, Henry, Green and Obion counties.

8. *Pseudacris brimleyi* Brandt and Walker

The Carolina chorus frog was described in 1933 from Washington, Beaufort county, North Carolina. As diagnosed, it is a medium-sized form with long legs and a triseriate dorsal pattern (like *triseriata*). In the specimens before me the digital expansions are unusually well developed for the genus. Well defined black stipplings on the chest occur in most individuals. Practically all characters that have been cited to diagnose *brimleyi* and *triseriata* are variable enough in the two populations to overlap considerably. This would suggest a possible subspecific relationship. In general, the dorsal pattern of *brimleyi* is relatively weak, with the dorsal stripes more or less constricted and undulate, while the lateral dark markings are relatively very distinct. This character alone seems best to serve to distinguish *brimleyi* from southeastern examples of *triseriata* on the basis of the limited material that I have been able to examine.

GEORGIA. Literature: Bryan county

NORTH CAROLINA. Literature: Beaufort, Craven, Edgecombe, Greene, Pitt and Wilson counties.

9. *Pseudacris nigrita nigrita* (LeConte)

This swamp chorus frog lives in the Coastal Plain. The dark triseriate bands that form lines in other populations break up more or less completely into rounded spots in this form. A definite linear arrangement of the spots is usually maintained.

ALABAMA. Literature: Mobile county.

FLORIDA. Literature: Duval and Nassau counties.

GEORGIA. Literature: Berrien, Charlton, Clinch, DeKalb, Liberty and Tift counties.

MISSISSIPPI. Literature: Hancock and Harrison counties.

NORTH CAROLINA. Literature: Beaufort, Columbus, Craven, Edgecombe, Greene, New Bern, Pitt and Wilson counties.

SOUTH CAROLINA. Charleston: Charleston (Barker). Literature: Greenville and Richland counties.

10. *Pseudacris nigrita triseriata* (Wied)

So far, I have been unable to distinguish the Carolina form now identified as *feriarum* from the wide-ranging *triseriata,* with which it admittedly agrees in having a basic triseriate pattern, coarser skin than *brimleyi,* and a medium size (20 to 38 mm. body length). I have been handicapped in my attempt to diagnose the two forms of striped chorus frogs by lack of material, due to the prior loan of the *Pseudacris* specimens in the U. S. National Museum, and also to my own poor luck in collecting them (largely seasonal, since I worked in the summer only). In U.S.N.M. No. 49850 from Halifax, N. C., the ratio of the width of the head into body length is 3.9 times; the body length into hind leg length is 1.23 times; and the heel only reaches the tympanic disc when the leg is applied forward alongside of the body. This Carolina frog definitely identifies as *triseriata* by the morphological criteria advanced by Dickerson (1906, p. 157) and quoted frequently by subsequent writers; however, on the geographical grounds used by recent workers it should be *feriarum.* Wright (1933), Brandt and Walker (1933), and Brandt (1936) all recognize that *triseriata* and *feriarum* are similar and appear to believe that one form inhabits Carolina. From all accounts I can find no convincing argument for the recognition of *feriarum* as a distinct form. The habitat of *triseriata* is in the uplands, particularly above the Fall Line, where it replaces the lowland-selecting *nigrita* and *brimleyi.* The voice record of *feriarum* from 7 mi. N. Vanceboro, Beaufort county, North Carolina (Harper, 1935), is very probably based on *nigrita* or *brimleyi.*

ALABAMA. *Jefferson:* Birmingham (Miller, February 7, 1914).

NORTH CAROLINA. *Durham:* Duke Univ. Campus (Gray, spring 1933). *Halifax:* Halifax (Marshall, 1913). Literature: Guilford, Orange, Vance and Wake counties.

SOUTH CAROLINA. Literature: Greenwood and Laurens counties.

TENNESSEE. *Putnam:* Cookeville (Burt, April 13, 1936). Literature: Blount Dyer, Obion and Sevier counties.

11. *Pseudacris nigrita verrucosa* (Cope)

This is the Florida chorus frog. Upon the examination of available material I am inclined to join Brady and Harper (1935) in giving recognition to this long overlooked subspecies, which was originally described in 1877. The best, and perhaps the only reliable, character appears to be that of the breaking up of the subocular light line in *verrucosa* as compared with its uniform confluence in other southeastern members of the nigrita-group. The dorsal spots are prominent and rounded in many specimens of *nigrita* and in *verrucosa* as well. The size of the two subspecies is about the same. Two examples from Gainsville, Fla., have the subocular line moderately broken, approaching the condition of intergradation with the northern *nigrita*. These were kindly loaned to me for examination by Mrs. Helen T. Gaige of the Museum of Zoölogy, University of Michigan.

FLORIDA. Literature: Alachua, Broward, Dade, Seminole and Volusia counties.

12. *Pseudacris ocularis* (Holbrook)

As an adult, the little chorus frog is the smallest saltatory amphibian in the Southeast, the body being under 19 mm. long, usually considerably less. It is another Coastal Plain species. The appearance of the body gives one the impression of weakness. The typical habitat is in zones of spring seepage at the edge of woods or in wet places near swamp margins.

FLORIDA. Literature: Alachua, Broward, Dade, Duval, Lee, Monroe and Nassau counties.

GEORGIA. *Brantley:* Hoboken (Burt, July 22, 1933). Literature: Bacon, Camden, Charlton, Emanuel, Pierce, Ware and Wayne counties.

MISSISSIPPI. Literature: Noxubee county.

NORTH CAROLINA. Literature: Beaufort, Columbus, Craven, New Hanover, Pitt, Robeson and Wilson counties.

SOUTH CAROLINA. Literature: Charleston and Hampton counties.

13. *Pseudacris ornata* (Holbrook)

As an adult the ornate chorus frog is the largest bodied representative of its genus in the Southeast. An excellent account of its biology has been published recently by Harper (1937). Facts pertaining to the taxonomy were given in one of my previous papers (1936) in which it was argued that *occidentalis* and *ornata* were confused by Cope and various later workers; *ornata*, originally described from the Southeast, appears to be the exclusive representative of its stock on the Coastal Plain from the Carolinas to Louisiana; *streckeri* (a close relative) replaces *ornata* in Texas and the lower Middle West; and *P. occidentalis*, originally described from California, is probably a synonym of the western *Hyla regilla*. Harper (1931) gave some pertinent facts on the taxonomy of *ornata* in Georgia, where he discerned that only one species occurs; placing *Hyla weberi* Noble (1923) and *Chorophilus copii* Boulenger (1882) into the synonymy.

ALABAMA. Literature: Mobile county.

FLORIDA. *St. Johns:* Hastings (Brimley, June, 1901). Literature: Alachua, Clay and Duval counties.

GEORGIA. Literature: Berrien, Burke, Camden, Charlton, Grady, Liberty and Ware counties.

MISSISSIPPI. Literature: Hancock and Harrison counties.

NORTH CAROLINA. Literature: Beaufort county.

SOUTH CAROLINA. Literature: Charleston and Richland counties.

14. *Hyla andersonii* Baird

The type of Anderson's tree frog (apparently named after a locality instead of a man) is U.S.N.M. No. 3600. It is soft and poorly preserved and the color pattern is practically indistinguishable. As seen in other individuals, the brown coloration of the flanks is distinct in some but obscure in others (especially in the young). The irregular brown band is probably most distinct in all as it passes obliquely downward from the eye through the tympanic area. In North Carolina this frog was reported by Brimley (1927) from Southern Pines, Moore county; and by Wright (1932) from Everetts Pond 10 mi. S.W. of Rockingham, Richmond county. In South Carolina the type was secured at Anderson, Anderson county, by Charlotte Paine; and other specimens near Charleston, Charleston county, by J. T. Rogers in 1924.

15. *Hyla avivoca* Viosca

In 1928, Viosca described the bird-voiced tree frog from Louisiana and relegated the name *phaeocrypta* (previously applied to what is now recognized as *avivoca* in the Southeast) to the synonymy of *versicolor*. It was held that the type of *phaeocrypta* is a fairly typical specimen of *versicolor*. Structurally the diagnosis of the new *avivoca* from *versicolor* is not very convincing, the main variation being in the voice, which is coarse in *versicolor* and shrill and bird-like in *avivoca*. The voice of *avivoca* might be called a "southern accent." Viosca believed *avivoca* to have a comparatively small size, a more slender form, a more truncate muzzle and more protuberant eyes. He describes its dorsal integument as "almost smooth," but the appearance of small tubercules on the back of the specimens that I have seen leads me to classify the species as a warty *Hyla*.

It appears that *avivoca* must have a wide distribution in the Southeast. Dunn (1927) reported it under the name of *phaeocrypta* as occurring in TENNESEE, at Nashville, Davidson county; while Endsley (1937) found 18 specimens on May 20-21, 1936, at South Fork, Forked Deer river bottom near Henderson, Chester county; and Parker (1937)) listed it from the Reelfoot lake area, Obion county. Harper (1933 and 1935) has recorded GEORGIA specimens from four counties: *Emanuel* (4 mi. N. Oak Park); Jefferson (Ogeechee river swamp 2 mi. S. Louisville); *Tattnall* (Ohoopee river at Shepard's bridge, 4 mi. S.W. Reidsville); and *Toombs* (Altamaha). Harper found an oblique forward slant of the white blotch below the eye to help distinguish *avivoca* from *versicolor* in Georgia, but it does not aid in the study of specimens from other areas, notably Louisiana.

16. *Hyla cinerea cinerea* (Schneider)

Dunn (1937) has considered the status of *Hyla evittata*, a northern variant of *cinerea*, which tends to have no conspicuous white stripe on each side of the body. He found that extensive intergradation exists between the two

populations of green tree frogs in the northern part of the range, and on this basis placed them as subspecies. The typical habitat is at the edge of swamps, river bottoms, ponds and slow flowing streams, especially in the Coastal Plain.

ALABAMA. *Mobile:* Mobile Bay (Thompson, April 20, 1892). *Montgomery:* Montgomery (Howell, April 19, 1912). Literature: Baldwin, Dale, Pike, Tuscaloosa and Wilcox counties.

FLORIDA. *Brevard:* Georgiana (Wittfield); Micco (Jenks). *Broward:* Pompano (Brady, February 22, 1932). *Collier:* Marco Island near Cape Romano (Velie). *Dade:* Lemon City (Brown, 1901); Miami (Brown, October, 1929); Paradise Key (Brady, January 27, 1932); Pinecrest (Brady, January 22, 1932). *Escambia:* Pensacola (Hammond). *Marion:* Dunnellon (Burt, August 1, 1937). *Monroe:* Big Pine Key (Hubbard, March, 1898). *Orange:* General report (Hurter, March 31, 1909). *Osceola:* Lake Kissimmee (Reese). *Pinellas:* Clearwater (Walker). *Putnam:* Palatka (Glover). *St. Lucie:* Eden (Green, April 19, 1889). *Santa Rosa:* Milton (Walker). *Seminole:* Sanford (Stahl, February 5, 1929). Literature: Alachua, Duval, Lake, Lee, Nassau, St. Johns and Volusia counties.

GEORGIA. *Baldwin:* Milledgeville (Kumlein and Bean, June 4, 1876). *Chatham:* Savannah (Burt, June 22, 1933). *Clinch:* Homerville (Burt, July 21, 1933). *Liberty:* Midway, and Riceboro (Burt, July 22, 1933). *McIntosh:* Eulonia (Burt, July 22, 1933). *Richmond:* Augusta (Hildebrand, May 9, 1918). *Ware:* Manor, and Waycross (Burt, July 21, 1933). Literature: Berrien, Camden, Charlton, Columbia, Decatur, Jefferson, Jenkins and Wayne counties.

MISSISSIPPI. *Adams:* Natchez (Burt, August 2, 1936). *Chickasaw:* Houston (Burt, June 12, 1934). *Hancock:* Bay St. Louis (Brimley, 1890). *Jackson:* Orange Grove (Burt, August 6, 1933). *Lauderdale:* Meridian (Burt, June 30, 1931). *LeFlore:* Greenwood (Burt, June 29, 1934). *Washington:* General report (Wailes). Literature: Harrison county.

NORTH CAROLINA. *Beaufort:* Washington (Gray, July 1, 1933). *Chowan:* Edenton (U. S. Bur. Fish.). Literature: Camden, Columbus, Craven, Dare, Lenoir, New Hanover, Pamlico and Richmond counties.

SOUTH CAROLINA. *Beaufort:* Beaufort (Hayden). *Horry:* Conway (Burt, July 23, 1933). Literature: Berkeley, Charleston, Chesterfield and Richland counties.

TENNESSEE. *Lauderdale:* Ashport (Burt, July 28, 1932). *Montgomery:* Clarksville (Howell, 1910). Literature: Obion county.

17. *Hyla crucifera* Wied

The spring peeper selects smaller streams and other bodies of water than does *Hyla cinerea*, so it is often found away from the swamps. On July 9, 1932, an individual was located among the limbs of a shrub over six feet above the bank of a mountain streamlet near Highlands, N. C.; and on June 14, 1934, the newly metamorphosed young were found on vegetation in moist woods in the Bowie Creek flats near Prentiss, Miss. The body length of two of the latter was 15 mm.

ALABAMA. Literature: Mobile and Montgomery counties.

FLORIDA. Literature: Alachua, Duval, Marion and Nassau counties.

Georgia. Literature: Randolph and Union counties.

Mississippi. *Jefferson Davis:* Prentiss on Bowie Creek Flats (Burt, June 14, 1934). Literature: Harrison county.

North Carolina. *Macon:* Highlands (Burt, July 9, 1932). *Mitchell:* Estatoe (Burt, August 6, 1937). *Yancey:* Burnsville (Burt, August 5, 1937). Literature: Ashe, Avery, Beaufort, Buncombe, Cherokee, Chowan, Craven, Guilford, McDowell, Orange, Richmond, Swain, Transylvania, Wake and Wayne counties.

South Carolina. Literature: Abbeville, Greene and Richland counties.

Tennessee. *Coffee:* Manchester (Burt, June 6, 1932). *Putnam:* Cookeville (Burt, April 13, 1936). Literature: Blount and Sevier counties.

18. *Hyla femoralis* Latreille

The discs on the toes of the pine-woods tree frog are moderately expanded and somewhat knoblike. The body is yellowish below, darker on the legs; upper surfaces gray or light brown with slate or dark-brown maikings; a triangular dark spot between the eyes, with the median horn of the triangle pointing backward and often bluntly formed; usually a large dark patch just anterior to the middle of the back, often with lateral horns that extend forward even to a point of fusion with the interocular spot. There are less developed dark spots on the posterior part of the back. The posterior face of the thigh exhibits a greater or lesser number of yellow or white spots which are very conspicuous on darker specimens. Individuals were found in amplexus in Ware county, Georgia, on July 21, 1933. This is a typical swamp frog.

Alabama. Literature: Baldwin, Mobile, Tuscaloosa and Washington counties.

Florida. *Hillsborough:* General report (Hurter, June 15, 1910). *Lake:* Fruitland Park (Reynolds). *Leon:* General report (Hurter, August 5, 1897). *Marion:* Silver Springs (Allen, 1937). *Polk:* Auburndale (Wood, March, 1912). Literature: Alachua, Clay, Duval, Nassau, Orange, Pinellas and Volusia counties.

Georgia. *Bryan:* Roding (Burt, July 22, 1933). *Clinch:* Homerville (Burt, July 21, 1933). *Liberty:* Riceboro (Burt, July 22, 1933). *McIntosh:* Eulonia (Burt, July 22, 1933). *Ware:* Manor (Burt, July 21, 1933). Literature: Berrien, Brantley, Camden, Charlton, Tattnall and Wayne counties.

Mississippi. Literature: Harrison county.

North Carolina. *Columbus:* Lake Waccamaw (Gray, July 3, 1933). Literature: Beaufort, Craven, Greene, New Hanover, Onslow and Pitt counties.

South Carolina. Literature: Berkeley and Charleston counties.

19. *Hyla gratiosa* LeConte

The barking tree frog inhabits the Coastal Plain, occurring about large ponds, swamps and other standing bodies of water. The body is capable of an unusual degree of inflation so that even a small individual may become very conspicuous as it floats on the water. When the frogs are sufficiently disturbed, deflation is rapid, followed by a dive to some point of concealment. When picked from the surface of the water an inflated frog may choose an opportune time to deflate, thus attempting to gain room enough for its re-

lease. *Hyla gratiosa* is typically a spotted frog, but no traces of spots occur in some individuals. There is considerable change in color and color pattern from time to time in living captives. The vitality of *gratiosa* appears to be less than that of *cinerea* and *versicolor* under laboratory conditions.

ALABAMA. Literature: Mobile and Tuscaloosa counties.

FLORIDA. *Brevard:* Georgiana (Wittfield). *Hillsborough:* General report (Hurter, November 20, 1912). *Lake:* Fruitland Park (Brown, October 20, 1922). *Marion:* Dunnellon (H. Williams, November, 1936). *Osceola:* Lake Kissimmee (Reese). Literature: Alachua, Baker, Clay, Duval, Nassau, Orange, Pinellas, St. Johns and Volusia counties.

GEORGIA. *Clinch:* Homerville (Burt, July 21, 1933). *McIntosh:* Eulonia (Burt, July 22, 1933). Literature: Charlton, Jenkins, Liberty and Wayne counties.

MISSISSIPPI. *Hancock:* Bay St. Louis (Allison, September 9, 1902). Literature: Harrison county.

NORTH CAROLINA. Literature: Beaufort county.

SOUTH CAROLINA. *Darlington:* Darlington (Burns, July 27, 1886). *Lexington:* Lexington (Burt, June 27, 1933). *McCormick:* McCormick (Burt, July 13, 1933).

20. *Hyla septentrionalis* Boulenger

The giant tree frog, which has been introduced into southern Florida from the West Indies (probably from Cuba, as announced by Barbour, 1931), is a gray, light-greenish or brownish species. The skin of the head is very completely involved in a striking type of dorsal cranial ossification. The back, sides and belly are covered with warts of varying sizes. The tips of the fingers and toes exhibit enormous clinging pads.

FLORIDA. *Dade:* Miami (Brady, February, 1932). *Monroe:* Key West, and Stock Island (Brady, 1932).

21. *Hyla squirella* Latreille

The swamp tree frog is a small species about the size of *Acris gryllus*. A light line often (but not always) passes along the upper lip, running below the eye to the side where it fades out. The back is brown or greenish, with or without dark spots; the skin is smooth; and the digits are moderately expanded. Amplexus was observed at a swampy area in Bryan county, Georgia, on July 22, 1933.

ALABAMA. *Baldwin:* Perdido Bay (Gutsell, 1911). Literature: Macon, Mobile and Montgomery counties.

FLORIDA. *Brevard:* Georgiana (Wittfield, 1883); Silver Lake 10 mi. W Titusville (Thompson). *Dade:* Coconut Grove (Rogers, December 19, 1924); Lemon City (Smith, February 15, 1895); Miami (Merritt, November 12, 1904); Pinecrest (Brady, January 22, 1932). *Escambia:* Pensacola (Hammond). *Marion:* Silver Springs (Allen, 1937). *Monroe:* Long Key (Howell, January 28, 1918); Lower Matacumba Key (Brady, April 16, 1932). *Palm Beach:* Palm Beach (Wood, 1915). Literature: Alachua, Clay, Duval, Hillsborough, Lake, Lee, Nassau, Orange, Osceola and St. Johns counties.

GEORGIA. *Brantley:* Hoboken (Burt, July 22, 1933). *Bryan:* Roding (Burt, July 22, 1933). *Clinch:* Homerville (Burt, July 21, 1933). *Liberty:* Riceboro (Burt, July 22, 1933). *McIntosh:* Eulonia (Burt, July 22, 1933). *Ware:* Manor (Burt, July 21, 1933). Literature: Berrien, Camden, Charlton, Jefferson, Jenkins and Pierce counties.

MISSISSIPPI. Literature: Hancock, Harrison and Jackson counties.

NORTH CAROLINA. *Robeson:* Lumberton (Gray, July 4, 1933). Literature: Beaufort, Brunswick, Chowan, Columbus, Craven, Currituck, Dare and New Hanover counties.

SOUTH CAROLINA. *Berkeley:* Oakley (Hayward). *Horry:* Conway (Burt, July 23, 1933). *McCormick:* McCormick (Burt July 13, 1933). Literature: Charleston and Richland counties.

22. *Hyla versicolor versicolor* LeConte

The difficulty of distinguishing preserved specimens of the common tree frog from *Hyla avivoca* has been discussed previously under that form. Common tree frogs are widespread in distribution in the Southeast, even in the mountains. Their voices are often heard at night and even in the daytime after showers. Tadpoles and metamorphosing young were found in White county, Tennessee, on July 23, 1932.

ALABAMA. *Autauga:* Autaugaville (Peters, May 10, 1914). *Greene:* Eutaw (Winchell). *Marion:* Hamilton (Burt, July 9, 1933). *Montgomery:* Montgomery (Howell, April 19, 1912). Literature: Jackson, Mobile, Tuscaloosa and Wilcox counties.

FLORIDA. Literature: Alachua and Duval counties.

GEORGIA. *Bartow:* Emerson (Burt, July 11, 1933). *Bryan:* Roding (Burt, July 22, 1933). *DeKalb:* Chamlee (Burt, July 12, 1933). *Floyd:* Rome (Burt, July 11, 1933). *Forsyth:* Cumming (Burt, June 30, 1933). *Habersham:* Clarksville (Burt, July 3, 1933). *Hall:* Between Belton and Lula (Burt, June 29, 1933). *Jenkins:* Millen (Benedict, July 4, 1932). *Liberty:* Midway (Burt, July 22, 1933). *McIntosh:* Eulonia (Burt, July 22, 1933). *Monroe:* Forsyth (Burt, July 20, 1933). *Muscogee:* Columbus (Garner). *Oconee:* Farmington (Burt, July 19, 1933). *Pickens:* Tate (Howell, July 4, 1908). Literature: Brantley, Charlton, Emanuel, Fannin, Jefferson, Lumpkin, Murray, Rabun, Tattnall, Toombs, Townes and Union counties.

MISSISSIPPI. *Adams:* Natchez (Wailes). *Chickasaw:* Houston (Burt, June 12, 1934). *Jefferson Davis:* Silver Creek (Burt, June 14, 1934). *Pontotoc:* Gershorm, and Pontotoc (Burt, June 12, 1934). *Tawamba:* Tremont (Burt, July 9, 1933). Literature: Hancock, Harrison, Kemper and Lauderdale counties.

NORTH CAROLINA. *Cherokee:* Valley River at Murphy (Burt, June 5, 1932). *Davidson:* Jackson Hill (Burt, July 17, 1933). *Edgecombe:* Tarboro (Bridger). *Forsyth:* Salem (Lineback). *Haywood:* Waynesville (U. S. N. M.). *McDowell:* Marion (Burt, July 31, 1933). *Mitchell:* Estatoe (Burt, August 6, 1937). *Randolph:* Farmer (Burt, July 16, 1933). *Swain:* Smokemont (Burt, June 8, 1932). *Wayne:* Goldsboro (Milner). *Yancey:* Burns-

ville (Burt, August 5, 1937). Literature: Beaufort, Camden, Currituck, Dare, New Hanover, Orange, Pitt, Richmond, Transylvania and Wake counties.

SOUTH CAROLINA. *Horry:* Conway (Burt, July 23, 1933). *McCormick:* McCormick (Burt, July 13, 1933). Literature: Anderson, Berkeley and Richland counties.

TENNESSEE. *Campbell:* Chaska (Burt, July 12, 1932). *Decatur:* Perryville (Burt, July 27, 1932). *Fentress:* Grimsley (Burt, July 25, 1932). *Knox:* Knoxville (Burt, July 21, 1932). *Loudon:* Lenoir City (Burt, August 11, 1937). *Macon:* Wilette (Burt, July 19, 1932). *Marion:* Whitwell (Burt, June 6, 1932). *Perry:* Linden (Burt, July 27, 1932). *Sevier:* Sevierville (Burt, July 18, 1932). *Smith:* Pleasant Shade (Burt, July 19, 1932). *Union:* Maynardsville (Burt, July 22, 1932). *White:* Bon Air (Burt, July 23, 1932). Literature: Blount, Dyer, Henry, McMinn, Obion and Shelby counties.

23. *Eleutherodactylus ricordii* (Duméril and Bibron)

This frog has a pink snout in life, but this feature is not very evident in preserved specimens, which merely have a uniform colored one. *E. ricordii* is about the size of *Acris gryllus.* The toes are slender with moderately expanded tips; tympanum small; eyes large; mouth not narrowed; skin finely granular; body brown or gray above, with irregular dark flecks or spots and a discernable dark interorbital bar between the eyes; immaculate below.

FLORIDA. *Dade:* Coconut Grove (Brown, 1929); Lemon City (Brown, 1901); Miami (Brady, February, 1932). *Monroe:* Big Pine Key (Bartsch, July 1, 1915); Key West (Brady, 1932). Literature: Alachua county.

24. *Rana areolata* Baird and Girard

Harper (1935) is followed in calling this the "crawfish frog" because it lives in crayfish holes instead of "gopher" (turtle) holes. The species appears to inhabit the Mississippi river valley and the Gulf coast. A drying carcass that was smashed flat on the road 2 miles north of Ecru, Pontotoc county, Mississippi, on June 12, 1934, had the dorsal coloration of *areolata* rather than that of *capito,* for the dark dorsal spots were definitely outlined with a white border. Allen (1932) listed specimens from Harrison county, Mississippi. This and the report from Dog River, Mobile county, Alabama, given by Loding (1932), are included here on geographical grounds. The Alabama, and even the Mississippi and southeastern Louisiana population as a whole may be largely intermediate between *areolata* and *capito,* as represented by the type specimens.

25. *Rana capito* LeConte

My conclusion in regard to the proper name for the southeastern gopher frog is in full agreement with that of Harper (1935). Upon my examination of the types of *areolata, aesopus* and *capito* at the United States National Museum the similarities of the three forms were found to be striking. No significant differences in leg length, head width, ventral coloration, granulation, structure of the tympanum or webbing of the feet were discernable. This is contrary in part to the findings of Cope (1889). The *aesopus* of Florida and the previously described *capito* of Georgia, as represented by the types and

additional specimens, are identical. In *capito* the dark spots between the dorsolateral folds are irregular in shape and size, and they are either inconspicuously outlined with a white border or have none at all. The latter condition prevails in most specimens. In *areolata* the large, dark spots are more rounded, and they are conspicuously outlined with white borders. In *capito* the large, dark cross-bands that cross the thighs tend to not have alternate small bands between them, contrary to the condition in *areolata*. Further examination reveals the fact that *capito* differs, on the average, in having more warts or tubercules on the back. The two forms were regarded as subspecies by Cope (1889) and it is not improbable that future study will support this stand.

FLORIDA. Literature: Alachua, Baker, Clay, Dade, Duval, Hillsborough, Indian River, Lake, Levy, Marion, Nassau, Orange, Palm Beach, Pasco, Pinellas, Polk, Putnam, St. Lucie and Volusia counties.

GEORGIA. Literature: Berrien, Brantley, Charlton, Fulton, Liberty and Ware counties.

NORTH CAROLINA. Literature: Beaufort county.

SOUTH CAROLINA. Literature: Hampton county.

26. *Rana catesbeiana* Shaw

The common bullfrog is widely disseminated in the southeast, but appears to be largely replaced by the smaller *grylio* in peninsular Florida. Bullfrogs are definitely darker in the Tennessee mountains than in the lowlands. This fact was even pointed out to me in 1932 by a fisherman who was examining my catch while I was bargaining for the purchase of turtles. Darker bullfrogs have their lips and under parts colored more or less like *heckscheri*, of the river swamps, but they usually lack a definite dark blotch in front of the insertion of the forelimb. The web of the hind foot is better developed in some individuals than in others in all three species of southeastern bullfrogs. It is presumed to extend past the last joint of the middle digit in *grylio* (and it does most of the time), but it sometimes does so in *catesbeiana* as well. In fact, the webbing on the right and left sides is sometimes asymmetrical. When used as a sole criterion the character of the webbing is unreliable. The dark ventral markings of *catesbeiana* are usually rather uniform in intensity or just a little darker under the hind legs, but in *grylio* there is (on the average) sharper contrast in this feature.

ALABAMA. *DeKalb:* Mentone (Burt, July 10, 1933). *Limestone:* Athens (Burt, July 8, 1933). *Shelby:* Longview (Holt, 1916). Literature: Mobile, Pike and Tuscaloosa counties.

FLORIDA. *Jefferson:* Aucilla (Howell, January 22, 1920). Literature: Alachua, Clay and Duval counties.

GEORGIA. *DeKalb:* Chamlee, and Lithonia (Burt, July 13, 1933). *Floyd:* Rome (Burt, July 11, 1933). *Gwinnett:* Thompson's Mill (Allard, May, 1910). *Liberty:* Riceboro (Baird). *Lincoln:* Lincolnton (Burt, July 6, 1933). *Rabun:* Burton Dam (Burt, July 3, 1933); Mountain City (Burt, July 2, 1933). *Walker:* LaFayette (Burt, July 8, 1933). *Ware:* Manor (Burt, July 21, 1933). Literature: Bacon, Chatham, Clinch, Columbia, Jefferson, Pierce, Randolph, Tattnall and Wayne counties.

MISSISSIPPI. *Chickasaw:* Houston (Burt, June 12, 1934). *Covington:* Collins (Burt, June 14, 1934). *Franklin:* Meadville (Burt, June 15, 1934). *Jasper:* Bay Springs, and Robert (Burt, June 14, 1934). *Jefferson Davis:* Silver Creek (Burt, June 14, 1934). *Jones:* Laurel (Burt, June 14, 1934). *Lawrence:* Silver Creek (Burt, June 14, 1934). *Lincoln:* Brookhaven (Burt, June 15, 1934). *Neshoba:* Philadelphia (Burt, June 14, 1934). *Newton:* Decatur (Burt, June 14, 1934). *Pontotoc:* Gershorm, and Pontotoc (Burt, June 12, 1934). *Yazoo:* Yazoo river, Eden (C. E. Young, August 7, 1934). Literature: Harrison county.

NORTH CAROLINA. *Chowan:* Edenton (Schwartz, June, 1913). *Edgecombe:* Tarboro (Bridger). *Jackson:* Cashiers (Burt, July 8, 1932). *Lee:* Sanford (Burt, July 7, 1932). *Macon:* Highlands (Burt, July 8, 1932); Lindenwood Lake (Burt, July 9, 1932). *McDowell:* Marion (Burt, July 31, 1933). *Rutherford:* Chimney Rock Camp (Weller, July 3, 1930). *Swain:* Smokemont (Burt, June 8, 1932). *Wake:* Raleigh (Jordan, 1888). *Wayne:* Little River at Goldsboro (Jordan, 1888). Literature: Ashe, Avery, Craven, Currituck, Dare, Duplin, Henderson, Madison, New Hanover, Orange, Sampson and Transylvania counties.

SOUTH CAROLINA. *Berkeley:* Oakley (Haywood). *Horry:* Conway (Burt, July 23, 1933). *McCormick:* Parksville (Burt, July 19, 1933). Literature: Charleston, Edgefield, Georgetown, Greenwood, Hampton, Laurens and Richland counties.

TENNESSEE. *Cheatham:* Shacklett (Burt). *Decatur:* Tennessee river at Perryville (Burt, July 27, 1932). *Fayette:* La Grange, and Oakland (Burt, June 12, 1934). *Fentress:* Grimsley (Burt, July 25, 1932). *Hamilton:* Ooltewah (Burt, June 4, 1932). *Knox:* Sequoya Hills in Knoxville (Burt, July 11, 1932). *Lauderdale:* Ashport (Burt, July 28, 1932). *Monroe:* Tellico Plains (1893). *Pickett:* Byrdstown (Burt, April 13, 1936). *Putnam:* Cookeville (Burt, April 6, 1936). *Union:* Maynardsville (Burt, July 22, 1932). Literature: Dyer, Green, Henry, Obion and Sevier counties.

27. *Rana clamitans* Latreille

The green frog is widely distributed in swampy areas and stream flats of the southeast, but records are few from peninsular Florida. Individuals taken at high altitudes are darker, as noted by Rhoads (1895) when he assigned two large examples from a spring on the summit of Roan Mountain, Mitchell county, North Carolina, to *Rana clamitans melanota,* which Rafinesque described in 1820 from the vicinity of Lake Champlain. The "black frog" was held to be a large, dark variety of *clamitans.* As I have maintained elsewhere, particularly in the study of the lizards of the genus *Cnemidophorus* (1931), color variation of this nature is subject to confusing geographic gradation and repetition and it often appears to be dubious diagnostic value in widespread forms, although local contrasts may be striking enough. Further experimental studies on the influence of temperature in producing and dispersing melanism in the amphibians and reptiles are much to be desired.

ALABAMA. *Colbert:* Leighton (Howell, May 24, 1914). *DeKalb:* Chavies (Burt, July 8, 1933). *Limestone:* Athens (Burt, July 8, 1933). *Mobile:*

Spring Hill (Benedict, July 10, 1932). Literature: Baldwin, Greene, Jackson, Montgomery, Shelby and Tuscaloosa counties.

FLORIDA. *Escambia:* Pensacola (Hammond). *Santa Rosa: Milton* (Walker). Literature: Alachua, Duval and Nassau counties.

GEORGIA. *Bartow:* Cass Station (Burt, July 11, 1933). *Columbia:* Evans (Burt, July 6, 1933). *Forsyth:* Cumming (Burt, June 30, 1933). *Gwinnett:* Duluth (Burt, July 20, 1933). *Liberty:* Riceboro (LeConte). Literature: Berrien, Camden, Charlton, Clinch, Fannin, Oglethorpe, Union, Ware and Wayne counties.

MISSISSIPPI. *Covington:* Collins (Burt, June 14, 1934). *Greene:* Piave (Burt, June 30, 1934). *Hancock:* Bay St. Louis (Bailey). *Jefferson Davis:* Prentiss, and Silver Creek (Burt, June 14, 1934). *Jones:* Laurel (Burt, June 14, 1934). *Lawrence:* Silver Creek (Burt, June 14, 1934). *Lincoln:* Brookhaven (Burt, June 15, 1934). *Newton:* Decatur, and Newton (Burt, June 14, 1934). *Pontotoc:* Gershorm (Burt, June 12, 1934). *Scott:* Forest (Burt, June 28, 1934). Literature: Harrison county.

NORTH CAROLINA. *Avery:* Kawana Lake at Linville (Clark and Robinson, September 26, 1916). *Bladen:* White Lake (Chitwood, July 5, 1930). *Buncombe:* Bent Creek 9 mi. SW Asheville (Gray, June 3, 1933). *Cherokee:* Ranger (Burt, June 6, 1932). *Macon:* Lindenwood Lake near Highlands (Burt, July 9, 1932). *Swain:* Cherokee (Mooney). *Union:* Monroe (Burt, July 18, 1933). Literature: Ashe, Beaufort, Craven, Duplin, Forsyth, Guilford, Haywood, Madison, Mitchell, New Hanover, Orange, Pender, Transylvania and Wake counties.

SOUTH CAROLINA. *Fayette:* LaGrange (Burt, June 12, 1934). *Hickman:* Centerville (Burt, July 27, 1932). *Macon:* Wilette (Burt, July 19, 1932). *McCormick:* Parksville (Burt, July 19, 1933). Literature: Anderson, Blount, Charleston, Davidson, Hamilton, Henry, Greenville and Richland counties.

TENNESSEE. *Putnam:* Cookeville (Burt, April 13, 1936). *Union:* Maynardsville (Burt, July 22, 1932). Literature: Blount, Obion, Polk, Roane and Sevier counties.

28. *Rana grylio* Stejneger

This relatively shy southern bullfrog inhabits the cypress and prairie swamps and sphagnum bogs rather than the more barren creek and river swamps of the coastal plains, as pointed out by Harper (1935). The ecological niche is in contrast to that of *heckscheri* of the same general area. The webbing of the hind foot is usually very well developed in *grylio,* but it may be the same in other bullfrogs as well and variation exists in all forms. Perhaps the best diagnostic character was advanced by Stejneger (1901) in the original description when he showed that the ratio of the length of the second toe of the hind foot to the length of the fourth toe of *grylio* is over 54 percent; but that in *catesbeiana* it is under this figure.

ALABAMA. Literature: Mobile county.

FLORIDA. *Broward:* Fort Lauderdale (Brady, March 12, 1932). *Dade:* Lemon City (Brown, 1901); Miami (Brady, January 14, 1932). *Hillsborough:* Tampa (Evermann and Kendall, 1876). *Marion:* Silver Springs (R. Allen,

1937). Literature: Alachua, Duval, Escambia, Nassau, Orange, Osceola, Palm Beach and Pinellas counties.

GEORGIA. *Bartow:* Cass Station (Burt, July 11, 1933). *Clinch:* Homerville (Burt, July 2, 1931). *Liberty:* Midway (Burt, July 22, 1933). Literature: Charlton, Chatham and Ware counties.

MISSISSIPPI. Literature: Hancock and Harrison counties.

29. *Rana heckscheri* Wright

The name river-swamp bullfrog seems appropriate for this species, although Harper (1932) called it the "alligator frog" or the "frog with the alligator voice." It appears to be a distinct species with a definite habitat selection as indicated above. Wright (1932) presented a long account of its life history and variation.

FLORIDA. *Hillsborough:* Tampa (Evermann and Kendall, 1896). *Marion:* Silver Springs (Ross Allen, 1937, tadpoles). Literature: Alachua, Baker, Duval and Nassau counties.

GEORGIA. *Berrien:* Nashville (Taylor, 1880). *Ware:* Swannee Lake (Harper, July 7, 1931). Literature: Charlton, Chatham, Clinch, Emanuel, Lowndes and Tattnall counties.

MISSISSIPPI. Literature: Harrison county.

SOUTH CAROLINA. Literature: Charleston county (Chamberlain, 1937).

30. *Rana palustris* LeConte

The pickerel frog is found in grass and leaves along woodland streams and brooks, even up in the mountains. It appears to be more delicate than the leopard frog, which it resembles. The diagnostic bright yellow on the thighs of *palustris* fades in preservatives. The dark spots on the back are nearly always paired and they are frequently squarish in shape; but the arrangement is not always distinctly transverse.

GEORGIA. *Stephens:* Foot of Toccoa Falls (Burt, June 29, 1933).

MISSISSIPPI. *Washington:* General report (Wailes).

NORTH CAROLINA. *Avery:* Linville (Clark and Robinson, October 26, 1916), (Burt, June 10, 1932). *Buncombe:* Bent Creek Forest Exp. Station (Gray, June 3, 1933). *Chowan:* Edenton (June, 1913). *Columbus:* Lake Waccamaw (Gray, July 3, 1933). *Lenoir:* Kinston (Milner). Literature: Ashe, Beaufort, Mitchell, New Hanover, Translyvania and Wake counties.

SOUTH CAROLINA. Literature: Richland county.

TENNESSEE. Literature: Carter, Henry and Roane counties.

31. *Rana pipiens* Schreber

The question of the status of the leopard frog named *Rana virescens sphenocephala* by Cope (1889) has been largely ignored of late in as far as critical work is concerned. The whole problem of the lack or presence of definable geographic races in the population known as *Rana pipiens* requires long and careful study—more than I have been able to give it to date (future statistical studies are contemplated).

Like Boulenger (1920) and Kellogg (1922), I am convinced that the past distinctions advanced to separate *pipiens* and *sphenocephala* are largely untenable. Contrary to the statement of Kauffeld (1937) that the name *sphenocephala* is universally accepted, the present tendency to hesitatingly report one or both forms from widely varied localities, often with the admission that a puzzle exists (Deckert 1914, Pickens 1927, Burt 1929, Parker 1937, *et al.*), is anything but consoling to one who strives to maintain logic and order in the taxonomic system. I have almost given up using the presence or absence of a white spot on the tympanum, or the possession of a longer or shorter head, in an attempt at diagnosis. The leopard frogs of the southeastern Coastal Plain average smaller as indicated by Wright and Wright (1933), as well as by the experience of those handling large quantities of leopard frogs for distribution to biological laboratories. The largest frogs appear to live in northern areas and in regions to the Southwest (including much of Texas). It appears that longer frogs tend to develop proportionately wider heads, but much individual (and probably local) variation exists. If one compares a Wisconsin or Michigan leopard frog with one from Florida, he usually notes that the dark dorsal spots are more or less round to transversely elongate in the southern specimens and that they are usually more or less longitudinally elongate in northern specimens (a distinction discerned by K. P. Schmidt). The contrast is sometimes very striking. In an attempt to present a working basis for the weighing of differences in the northern and southern leopard frogs, the following key, which is purely tentative, is submitted.

1. Dark spots on back between dorsolateral folds usually more or less rounded in outline or expanded transversely, and with white borders comparatively faint or absent; often with fewer dark markings on sides; large adults usually not over 3¼ inches long, snout to anus. Coastal Plain and river valleys, mostly below the Fall Line, Virginia to Texas. Southern leopard frog.
Rana pipiens sphenocephala Cope.

1. Dark spots on back usually more or less longitudinally elongate, and with white borders better developed, often conspicuous; large adults over 3¼ inches long. Southeastern states above the Fall Line, and points north and west. Northern leopard frog.................................*Rana pipiens pipiens* Schreber.

If the two variants are to be recognized in the future, I cannot conceive of them as full species, agreeing with Pickens (1927), who recorded the intermating of what he regarded as the two forms at a point above the Fall Line in South Carolina. For the present at least, Kellogg (1932) is followed in listing only *pipiens* in its complex. He interpreted such designations as *utricularis, berlandieri, sphenocephala, brachycephala, burnsi* and *kandiyohi* as individual variations, commenting as follows: "This conclusion has been reached after a critical examination and tabulation of many specimens. No constant geographic peculiarities were encountered among the specimens studied. Unique variations in color pattern were found in almost every local series, and as none of these variations are exactly alike, it seems necessary to disregard such peculiarities and group all of the leopard frogs of North and Central America under one name."

Kauffeld (1937) has presented a number of definitely stated conclusions regarding the status of *Rana brachycephala, R. pipiens* and *R. sphenocephala*, and it would appear from his data (the measurements of the head particularly) that the three forms are very distinct units; in fact he says that the first two

are so distinct that they can be readily identified "even at a distance of ten feet." Unfortunately Kauffeld does not support his argumentation with measurements. The data of Boulenger (1920) point to a different conclusion: "In the specimens examined by me, the proportion of the head to the body does not give very satisfactory results." According to Kauffeld, *Rana sphenocephala* has the "snout long; head length entering body length 2 to 2½ times." In other words, head length 40 to 50 percent of body length. Boulenger measured "*sphenocephala*" from Florida, Mississippi and Texas and recorded this variation as 32 to 37 percent. Kauffeld diagnoses *Rana pipiens* as follows: "Snout shorter, head length entering body length 3 to 3½ times." In other words, head length 28.6 to 33.3 percent of body length. He lists the distribution of *pipiens* as "Extreme southeastern New York, Long Island, southern Connecticut, New Jersey except the northwestern portion, southeastern Pennsylvania, Delaware and Maryland." *Sphenocephala* is presumed to range south through the Coastal Plain, west to Texas. In the rest of the United States, as far as the Pacific area, *brachycephala* is held to occur. Boulenger does not give head measurements of *pipiens* that can be compared with those of Kauffeld. Kauffeld diagnosed *brachycephalia* as follows: "Snout very short; head entering body length 3½ to 4 times." This means head length 25 to 28.6 percent of body length. Boulenger's figures for specimens from western Canada, Illinois, Michigan, Idaho, Indiana, Colorado and Arizona, undoubtedly in the range ascribed to *brachycephala* by Kauffeld, were 30 to 36 percent! This compares with Boulenger's 32 to 37 percent for *sphenocephala* and thereby indicates no significant divergence.

ALABAMA. *Limestone:* 14 mi. W Athens (Burt, July 8, 1933). *Washington:* Deer Park (Benedict, July, 1932); Leroy (Burt, August 6, 1933). *Wilcox:* Pine Hill (Godbold, October 11, 1919). Literature: Mobile, Montgomery and Tuscaloosa counties.

FLORIDA. *Clay:* Orange Park (Miller, August 19, 1931). *DeSoto:* Orange Hammock (Palmer, March, 1895). *Hillsborough:* Tampa (Evermann and Kendall, November 3, 1896). *Lake:* Esmeralda (Brown, February 25, 1923); Eustis (Holm, February 12, 1893). *Monroe:* Big Pine Key (Brady, 1932). *Palm Beach:* Ritta (Robbins, May, 1918). *St. Johns:* St. Augustine (Smith). *St. Lucie:* Eden (Green, April 18, 1889). *Santa Rosa:* Milton (Walker). *Seminole:* Sanford (Stoner, 1928). Literature: Alachua, Dade, Duval, Escambia, Lee, Orange, Pinellas and Volusia counties.

GEORGIA. *Brantley:* Hoboken, and Lulaton (Burt, July 22, 1933). *Bryan:* Roding (Burt, July 22, 1933). *Clinch:* Homerville (Burt, July 21, 1933). *Columbia:* Evans (Burt, July 6, 1933). *Glynn:* Brunswick (Burt, July 22, 1933). *McIntosh:* Eulonia (Burt, July 22, 1933). *Walker:* LaFayette (Burt, July 8, 1933). *Ware:* Manor and Waycross (Burt, July 21, 1933). Literature: Berrien, Charlton, Chatham, Liberty, Lowndes, Randolph and Tattnall counties.

MISSISSIPPI. *Amite:* Glading (Burt, July 1, 1934). *Benton:* Michigan City (Howell, September 23, 1908). *Chickasaw:* Houston (Burt, June 12, 1934). *Covington:* Collins (Burt, June 19, 1934). *Franklin:* Meadville (Burt, June 15, 1934). *Greene:* Piave (Burt, June 30, 1934). *Hancock:* Bay St. Louis (Bailey, April 22, 1892). *Jasper:* Bay Springs (Burt, June 14, 1934). *Jefferson Davis:* Prentiss (Burt, June 14, 1934). *Jones:* Laurel and Welch (Burt, June

14, 1934). *Lawrence:* Monticello (Burt, June 15, 1934). *Newton:* Decatur and Newton (Burt, June 14, 1934). *Pontotoc:* Gershorm (Burt, June 12, 1934). *Wayne:* Clara Chicora (Burt, June 30, 1934). *Wilkinson:* Ireland (Burt, July 1, 1934). Literature: Harrison county.

NORTH CAROLINA. *Chowan:* Edenton (Schwartz, June, 1913). *Craven:* Havelock (Metcalf and Ewing, 1929). *Durham:* Durham (Burt, July 14, 1933). *Edgecombe:* Tarboro (Bridger). *Forsyth:* Winston-Salem (Lineback). *Lee:* Sanford (Burt, July 7, 1932). *Montgomery:* Biscoe (Burt, July 7, 1932). *Wayne:* Goldsboro (Burt, July 7, 1932). Literature: Camden, Carteret, Currituck, Dare, Duplin, New Hanover,, Sampson and Wake counties.

SOUTH CAROLINA. *Berkeley:* Oakley (Hayward, May, 1879). *Chester:* Chester (Burt, July 18, 1933). *Horry:* Conway (Burt, July 23, 1933). *Lexington:* Leesville (Brodie, June, 1932). *Saluda:* Saluda (Burt, July 18, 1933). Literature: Aiken, Charleston, Chesterfield, Greenville and Richland counties.

TENNESSEE. *Blount:* Louisville (Burt, July 21, 1932). *Carroll:* McKenzie (Burt, June, 4, 1932). *Clay:* Celina (Burt, July 20, 1932. *Fayette:* La-Grange, and Somerville (Burt, June 12, 1934). *Humphrey:* Denver (Burt, June 5, 1932). *Putnam:* Cookeville (Burt, April 13, 1936). *Sequatchie:* Dunlap (Burt, July 26, 1932). *Sevier:* Sevierville (Burt, July 18, 1932). Literature: Dyer, Hamilton, Henry, Obion and Shelby counties.

32. *Rana sylvatica* LeConte

Wood frogs are not frequently encountered in the southern part of their range; and in the Southeast they appear to be confined to the Carolinas. The body is light brown above and below, with black spots usually scattered along the dorsolateral skin fold and the sides of the head. A peculiar dark mask usually runs from the face through the eye and tympanum to above the forearm.

NORTH CAROLINA. *Avery:* Linville (Clark and Robinson). *Lenoir:* Kinston (Milner). Literature: Ashe and Watauga counties.

SOUTH CAROLINA. Literature: Anderson county.

33. *Rana virgatipes* Cope

The carpenter frog averages smaller than the green frog and the leopard frog. The body is dark to light chocolate brown above. There are two light lines on each side after metamorphosis, but these fade out or become indistinct in older specimens, especially anteriorly and on the lower sides. Scattered dark spots of small size are on the back and thighs; and the under parts are yellow, more or less mottled with dark-brown spots and patches as in young bullfrogs. The toes have the phalanges drawn out to sharp points, so that they are not particularly rounded at the tips.

GEORGIA. Literature: Charlton and Ware counties.

NORTH CAROLINA. Literature: Beaufort, Carteret, Craven, Cumberland, Moore, New Hanover, Richmond and Washington counties.

34. *Microhyla carolinensis* (Holbrook)

Narrow-mouthed toads are very numerous in the Southeastern States, especially in the Coastal Plain. Many of them are found under logs in damp woods. The under surface is brown, mottled in many examples, but in others

it is rather uniform white or yellowish. The back may be uniform brown or purplish, often with the sides darkened by a more or less developed longitudinal band. Some backs are more or less spotted. Specimens from Key West tend to develop two narrow irregular lines of dark brown, with variation evident. These lines are represented by numerous dark spots in an example from Cedar Key, far to the north and west.

ALABAMA. *Cullman:* Ardell (Peters, May 30, 1914). Literature: Baldwin, Calhoun, Cherokee, Etowah, Macon, Mobile, Montgomery, Shelby, St. Clair and Tuscaloosa counties.

FLORIDA. *Dade:* Pinecrest (Brady, January 22, 1932). *Lee:* Fort Myers (Hurter, June 20, 1910). *Levy:* Cedar Keys (Miller, March 17, 1926). *Monroe:* Big Pine Key (Brady); Key West (Butts, September 10, 1919). *Osceola:* Kissimmee (1911). *Pinellas:* St. Petersburg (Reynolds). Literature: Alachua, Duval, Escambia, Hillsborough, Orange, Santa Rosa and Volusia counties.

GEORGIA. *Bartow:* Emerson (Burt, July 11, 1933). *Brantley:* Hoboken, and Lulaton (Burt, July 22, 1933). *Dooly:* Vienna (Burt, July 20, 1933). *Floyd:* Rome (Burt, July 11, 1933). *Glynn:* Brunswick (Burt, July 22, 1933). *Hall:* Between Belton and Lula (Burt, June 29, 1933). *Liberty:* Riceboro (Burt, July 22, 1933). *Lincoln:* Island above Price Island in Savannah river (Burt, July 19, 1933); Lincolnton (Burt, July 6, 1933). *Lowndes:* Valdosta (Burt, July 21, 1933). *McIntosh:* Eulonia (Burt, July 22, 1933). *Ware:* Manor, and Waycross (Burt, July 22, 1933). Literature: Charlton, Chattahoochee, DeKalb, Fulton, Muscogee, Ware and Wayne counties.

MISSISSIPPI. *Chickasaw:* Houston (Burt, June 12, 1934). *Jefferson Davis:* Prentiss (Burt, June 14, 1934). *Neshoba:* Philadelphia (Burt, June 14, 1934). *Newton:* Doolittle (Burt, June 14, 1934). *Oktibbeha:* General report (Greene, 1910). *Pontotoc:* Gershorm, and Pontotoc (Burt, June 12, 1934). *Sunflower:* Moorehead (Burt, June 29, 1934). *Tawamba:* Tremont (Burt, July 9, 1933). *Webster:* Tomnolen (Burt, June 30, 1934). Literature: Hancock, Harrison, Lafayette, Lauderdale and Washington counties.

NORTH CAROLINA. *Durham:* Hope Valley (Burt, July 14, 1933). Literature: Beaufort, Cumberland, Craven, Halifax, Johnson, Lenoir, Moore, New Hanover, Polk, Wake and Wayne counties.

SOUTH CAROLINA. *Beaufort:* Hardeeville (Burt, July 23, 1933). *Columbus:* Lake Waccamaw (Gray, July 3, 1933). *Lexington:* Leesville (Brodie, June 9, 1933). *Saluda:* Saluda (Burt, July 5, 1933). Literature: Charleston and Richland counties.

TENNESSEE. Literature: Hamilton, Henry, McMinn, Shelby and Sullivan counties.

BIBLIOGRAPHY

ALLEN, MORROW J. 1932. A Survey of the Amphibians and Reptiles of Harrison County, Mississippi. Amer. Mus. Novitates, 542:1-20.

BAILEY, JOSEPH R. 1936. *Microhyla carolinensis* in Northeastern Tennessee. Copeia, 2:115.

BARBOUR, THOMAS. 1919. The Herpetology of Cuba. Mem. Mus. Comp. Zoöl., 47:71-213, pls. 1-15.

——— 1931. Another Introduced Frog in North America. Copeia, 3:140.

BISHOP, SHERMAN C. 1928. Notes on Some Amphibians and Reptiles from the Southeastern States with a Description of a New Salamander from North Carolina. Jour. Elisha Mitchell Sci. Soc., 43:153-170, pls. 23-26.

BLANCHARD, FRANK N. 1922. The Amphibians and Reptiles of Western Tennessee. Occas. Pap. Mus. Zoöl., Univ. Mich., 117:1-18.

BOULENGER, G. A. 1920. A Monograph of the American Frogs of the Genus *Rana*. Proc. Amer. Acad. Arts and Sci., 55:413-480.

BRADY, MAURICE K., and FRANCIS HARPER. 1935. A Florida Subspecies of *Pseudacris nigrita* (Hylidae). Proc. Biol. Soc. Wash., 48:107-110.

BRANDT, B. B. 1936. The Frogs and Toads of Eastern North Carolina. Copeia, 4:215-223.

BRANDT, B. B., and WALKER, C. F. 1933. A New Species of *Pseudacris* from the Southeastern United States. Occas. Pap. Mus. Zoöl., Univ. Mich., 272:1-7, pl. 1.

BREDER, C. M., and BREDER, RUTH B. 1923. A List of Fishes, Amphibians and Reptiles Collected in Ashe County, North Carolina. Zoölogica, 4:1-23.

BRIMLEY, C. S. 1909. Some Notes on the Zoölogy of Lake Ellis, Craven County, North Carolina, with Special Reference to Herpetology. Proc. Biol. Soc. Wash., 22:129-138.

——— 1910. Records of Some Reptiles and Batrachians from the Southeastern United States. *Ibid.*, 23:9-18.

——— 1915. List of Reptiles and Amphibians of North Carolina. Jour. Elisha Mitchell Sci. Soc., 30:195-205.

——— 1922. Herpetological Notes from North Carolina. Copeia, 107:47-48.

——— 1923. North Carolina Herpetology. *Ibid.*, 114:3-4.

——— 1926. Revised Key and List of the Amphibians and Reptiles of North Carolina. Jour. Elisha Mitchell Sci. Soc., 42:75-93.

BRIMLEY, C. S., and MABEE, W. B. 1925. Reptiles, Amphibians and Fishes Collected in Eastern North Carolina in the Autumn of 1923. Copeia, 139:14-16.

BURT, CHARLES E. 1931. A study of the Teiid Lizards of the Genus *Cnemidophorus* with Special Reference to their Phylogenetic Relationships. Bull. U. S. Nat. Mus., 154:1-286, figs. 1-38.

——— 1932. Records of Amphibians from the Eastern and Central United States (1931). Amer. Midland Naturalist, 13:75-85.

——— 1935. Further Records of the Ecology and Distribution of Amphibians and Reptiles in the Middle West. *Ibid.*, 16:311-336.

——— 1936. Contributions to the Herpetology of Texas. I. Frogs of the Genus *Pseudacris*. *Ibid.*, 17:770-775.

——— 1938. The Lizards of the Southeastern United States. Trans. Kansas Acad. Sci. 40:349-366. 1937.

CARTER, H. A. 1934. Georgia Records of *Gastrophryne carolinensis* (Holbrook). Copeia, 3:138.

COPE, EDWARD D. 1877. Tenth Contribution to the Herpetology of Tropical America. Proc. Amer. Philos. Soc., 17:85-98.

——— 1889. The Batrachia of North America. Bull. U. S. Nat. Mus., 34:1-525, text figs. 1-119, pls. 1-86.

CORRINGTON, J. D. 1927. Field Notes on Some Amphibians and Reptiles at Biloxi, Mississippi. Copeia, 165:98-102.

——— 1929. Herpetology of the Columbia, South Carolina, Region. *Ibid.*, 172:58-83.

DECKERT, R. F. 1914a. List of Salientia from near Jacksonville, Florida. *Ibid.*, 3:3.

——— 1914b. Further Notes on the Salientia of Jacksonville, Florida. *Ibid.*, 5:2-4, 9:1-3.

——— 1915a. *Ibid.* (Cont.). *Ibid.*, 18:3-5.

——— 1915b. Concluding Notes on the Salientia of Jacksonville, Florida. *Ibid.*, 20:21-24.

——— 1920. Note on the Florida Gopher Frog. *Ibid.*, 80:26.

——— 1921. Amphibian Notes from Dade County, Florida. *Ibid.*, 92:20-23.

——— 1922. Notes on Dade County Salientia. *Ibid.*, 112:88.

DICKERSON, MARY C. 1906. The Frog Book. Doubleday, Doran and Co., pp. 1-253, figs. 1-290.

DUNN, EMMETT R. 1917. Reptile and Amphibian Collections from the North Carolina Mountains, with Especial Reference to Salamanders. Bull. Amer. Mus. Nat. Hist., 37:593-634.

——— 1927. *Hyla phaeocrypta* in Tennessee. Copeia, 162:19.

——— 1937. The Status of *Hyla evittata* Miller. Proc. Biol. Soc. Wash., 50:9-10.

ENDSLEY, J. R. 1937. The Occurrence of *Hyla avivoca* in Western Tennessee. Copeia, 1:70.

FOWLER, HENRY W. 1906. Some Cold-blooded Vertebrates of the Florida Keys. Proc. Acad. Nat. Sci. Phila., pp. 77-122.

——— 1917. Cold-blooded Vertebrates from Florida. Copeia, 43:38-39.

HARPER, FRANCIS. 1930. Notes on Fishes, Amphibians and Reptiles of Randolph County, Georgia. *Ibid.*, 4:152-154.

——— 1931a. Notes on two Georgia Species of *Pseudacris*. *Ibid.*, 4:159.

——— 1931b. A Dweller in the Piney Woods. Sci. Mo., 32:176-181.

——— 1933. A Tree Frog New to the Atlantic Coastal Plain. Jour. Elisha Mitchell Sci. Soc., 48:228-231.

——— 1935a. The Name of the Gopher Frog. Proc. Biol. Soc. Washington, 48:79-82.

——— 1935b. Records of Amphibians in the Southeastern United States. Amer. Midland Naturalist, 16:275-310.

——— 1937. A Season with Holbrook's Chorus Frog (*Pseudacris ornata*). *Ibid.*, 18:260-272.

HOLT, ERNEST G. 1924. Additional Records for the Alabama Herpetological Catalogue. Copeia, 135:93-95.

KAUFFELD, CARL F. 1937. The Status of Leopard Frogs, *Rana brachycephala* and *Rana pipiens*. Herpetologica, 1:84-87.

KELLOGG, REMINGTON. 1932. Mexican Tailless Amphibians in the United States National Museum. Bull. U. S. Nat. Mus., 160:1-224.

LODING, H. P. 1922. A Preliminary Catalogue of Alabama Amphibians and Reptiles. Mus. Pap. Geol. Sury. Alabama, 5:1-59.

LOENNBERG, EINAR. 1894. Notes on Reptiles and Batrachians Collected in Florida in 1892 and 1893. Proc. U. S. Nat. Mus., 17:317-339.

MYERS, GEORGE S. 1924. Amphibians and Reptiles from Wilmington, N. C. Copeia, 131:59-62.

—— 1927. The Differential Characters of *Bufo americanus* and *Bufo fowleri*. *Ibid.*, 163:50-53.

NECKER, WALTER L. 1934. Contribution to the Herpetology of the Smoky Mountains of Tennessee. Bull. Chicago Acad. Sci., 5:1-4.

PARKER, MALCOLM V. 1937. Some Amphibians and Reptiles from Reelfoot Lake. Jour. Tennessee Acad. Sci., 12:60-86, figs. 1-18.

PICKENS, A. L. 1927. Amphibians of Upper South Carolina. Copeia, 165:106-110.

POTTER, DOREEN. 1920. Reptiles and Amphibians Collected in Northern Mississippi in 1919. *Ibid.*, 86:82-83.

RAFINESQUE, C. S. 1820. Annals of Nature or Annual Synopsis of New Genera and Species of Animals, Plants, etc., Discovered in North America. Printed privately, pp. 1-16.

RHOADES, S. N. 1895. Contributions to the Zoölogy of Tennessee. I. Reptiles and Amphibians. Proc. Acad. Nat. Sci. Phila., 47:276-407.

SCHMIDT, KARL P. 1916. Notes on the Herpetology of North Carolina. Jour. Elisha Mitchell Sci. Soc., 32:33-37.

—— 1924. A List of Amphibians and Reptiles Collected near Charleston, S. C. Copeia, 132:67-69.

SMITH, HOBART M. 1934. The Amphibians of Kansas. Amer. Midland Naturalist, 15:377-528, maps 1-24, pls. 12-20.

STEJNEGER, LEONHARD. 1901. A New Species of Bullfrog from Florida and the Gulf Coast. Proc. U. S. Nat. Mus., 24:211-215.

VAN HYNING, O. C. 1933. Batrachia and Reptilia of Alachua County, Florida. Copeia, 1:3-7.

VAN HYNING, T. 1923. A Collecting Note on Florida Batrachians. *Ibid.*, 118:68.

VIOSCA, PERCY. 1928. A New Species of *Hyla* from Louisiana. Proc. Biol. Soc. Wash., 41:89-92.

WRIGHT, ANNA ALLEN, and WRIGHT, ALBERT HAZEN. 1933. Handbook of Frogs and Toads. Comstock Pub. Co., pp. 1-231, pls. 1-82.

WRIGHT, ALBERT HAZEN. 1924. A New Bullfrog (*Rana heckscheri*) from Georgia and Florida. Proc. Biol. Soc. Wash., 37:141-152.

—— 1932. Life Histories of the Frogs of Okefinokee Swamp, Georgia. Macmillan Co., pp. 1-497, pls. 1-45.

FIGURES 1, 2, 3, 4

FIG. 1. *Bufo americanus americanus.* Imboden, Ark. Top of head.

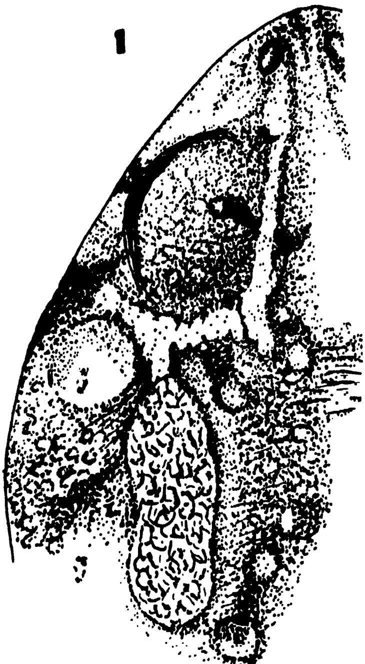
FIG. 2. *Bufo americanus terrestris.* Lake Cherry, Fla. U. S. N. M., No. 78468. Top of head.

FIG. 3. *Bufo woodhousii fowleri.* Fentress Co., Tenn. Top of head.

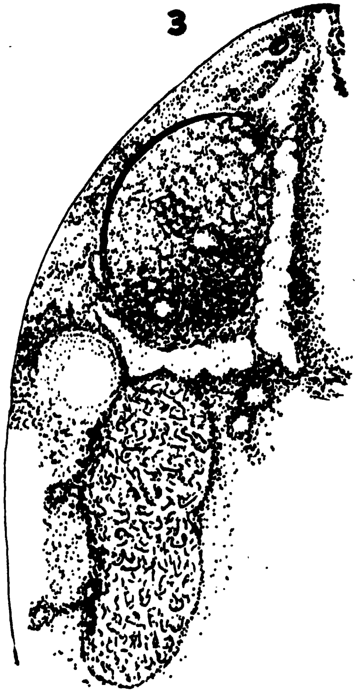
FIG. 4. *Bufo quercicus.* Silver Springs, Fla. Top of head.

FIGURES 1, 2, 3, 4

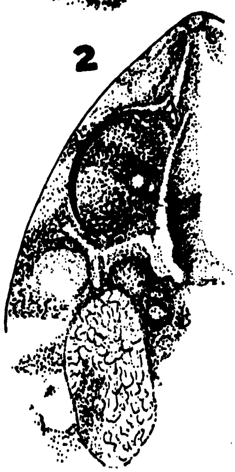
1



3



2



4

FIGURES 5 TO 13

FIG. 5. *Pseudacris nigrita triseriata.* Washington, N. C. U. S. N. M., No. 91743. Right hind foot, ventral view.

FIG. 6. *Hyla andersonii.* Lakehurst, N. J. U. S. N. M., No. 37849. Right front foot, ventral view.

FIG. 7. *Hyla septentrionalis.* Stock Island, Monroe Co., Fla. U. S. N. M., No. 85397. Right hind foot, ventral view.

FIG. 8. *Rana sylvatica.* Linville, N. C. U. S. N. M., No. 55159. Right hind foot, ventral view.

FIG. 9. *Pseudacris brimleyi.* Washington, N. C. U. S. N. M., No. 99055. Right hind foot, ventral view.

FIG. 10. *Rana virgatipes.* Chesser's Island, Okefinokee Swamp, Ga. U. S. N. M., No. 84613. Left hind foot, ventral view.

FIG. 11. *Rana catesbeiana.* Texas. Dorsal view of hind foot.

FIG. 12. *Rana grylio.* Miami, Fla. U. S. N. M., No. 85357. Dorsal view of hind foot.

FIG. 13. *Scaphiopus holbrookii holbrookii.* Silver Springs, Fla. Ventral view of hind foot showing spade.

FIGURES 5 TO 13

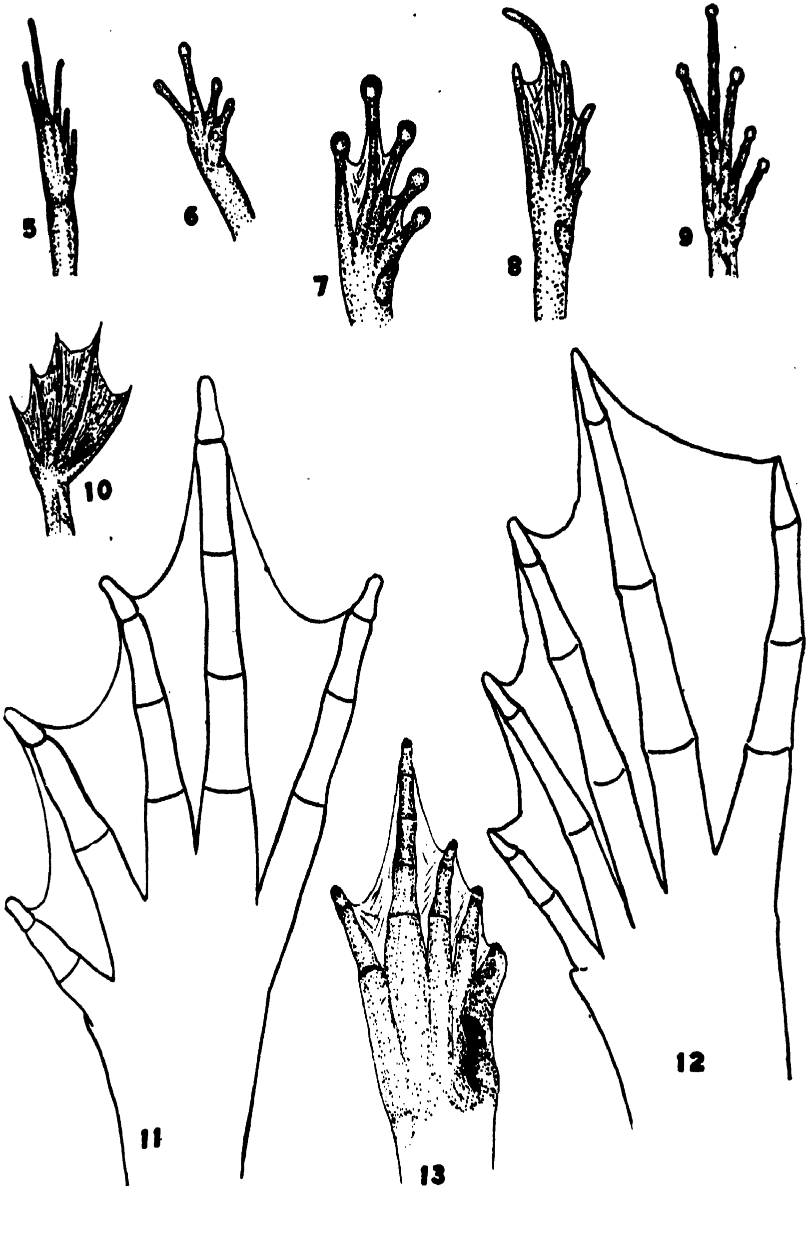


FIGURE 14

FIG. 14. *Rana capito.* Silver Springs, Fla. Dorsal view showing color pattern.

FIGURE 14

Concerning the Postnatal Obliteration of the Umbilical Vein and Arteries, the Vitelline Vein and Artery, and the Ductus Arteriosus in the Guinea Pig[1]

MARY T. HARMAN, Kansas State College, Manhattan, Kan., and
JAMES E. HERBERTSON, University of Oregon, Eugene, Ore.

INTRODUCTION

The functional modifications of the circulatory system are among the most extensive of the postnatal changes.

The purpose of this investigation is to determine the rate and type of obliteration which take place in the umbilical vein and arteries, the vitelline vein and artery, and the ductus arteriosus in the guinea pig after birth.

REVIEW OF LITERATURE

According to Scammon and Norris (1918), many of our current concepts of the postnatal obliteration of the fetal blood passages which occur in man probably can be traced to the early investigations of the French clinician, Billard (1828), who collected data on the obliteration of the ductus venosus, the ductus arteriosus, and the foramen ovale, in a series of 128 children who died in the first eight days of life. Billard's observations were confirmed by Bernutz (1865), who found variation in the stages of closure of the ductus arteriosus in a series of 59 children who died between the tenth and the 60th days of life. Elasasser (1852), in a series of nearly 300 observations upon children of the first month, found obliteration of the ductus arteriosus in about two percent, and of the foramen ovale in about three percent of his cases. Alvarenga (1869) found practically no instances of obliteration of the ductus arteriosus nor the foramen ovale before 60 days in life. The findings of later observers, Alexeieff (1900), Theremin (1887 and 1895), Kucheff (1901), and others agree essentially with those of Elasasser and Alvarenga, although they have noted some instances of earlier obliteration of these passages. Considerable data have been compiled by Scammon and Norris (1918) concerning the postnatal obliteration of the ductus arteriosus, the ductus venosus, and the foramen ovale.

A review of the available literature indicates that (1) most of the work concerning the postnatal obliteration of the fetal blood passages has been done in man; (2) very little work of this nature has been done with other animals; (3) the investigations have dealt, for the most part, with the ductus arteriosus, the ductus venosus, and the foramen ovale. Bryce (1908), with reference to the obliteration of fetal blood passages in man, states that it commences at birth, and is perceptible after a few respirations have occurred. It makes rapid progress in the first and second days, and by the third or fourth day the passage through the umbilical arteries is usually completely interrupted. The ductus arteriosus is rarely found open after the eighth or the tenth day, and by

1. Contribution No. 191 from the zoölogy department of Kansas State College of Agriculture and Applied Science. The authors wish to thank Dr. H. L. Ibsen, of the Animal Husbandry Department, for furnishing the guinea pigs for this investigation.

three weeks it has in almost all instances become completely impervious. The process of closure of the veins is slower; but they remain empty of blood and collapsed, and by the sixth or seventh day they are generally closed.

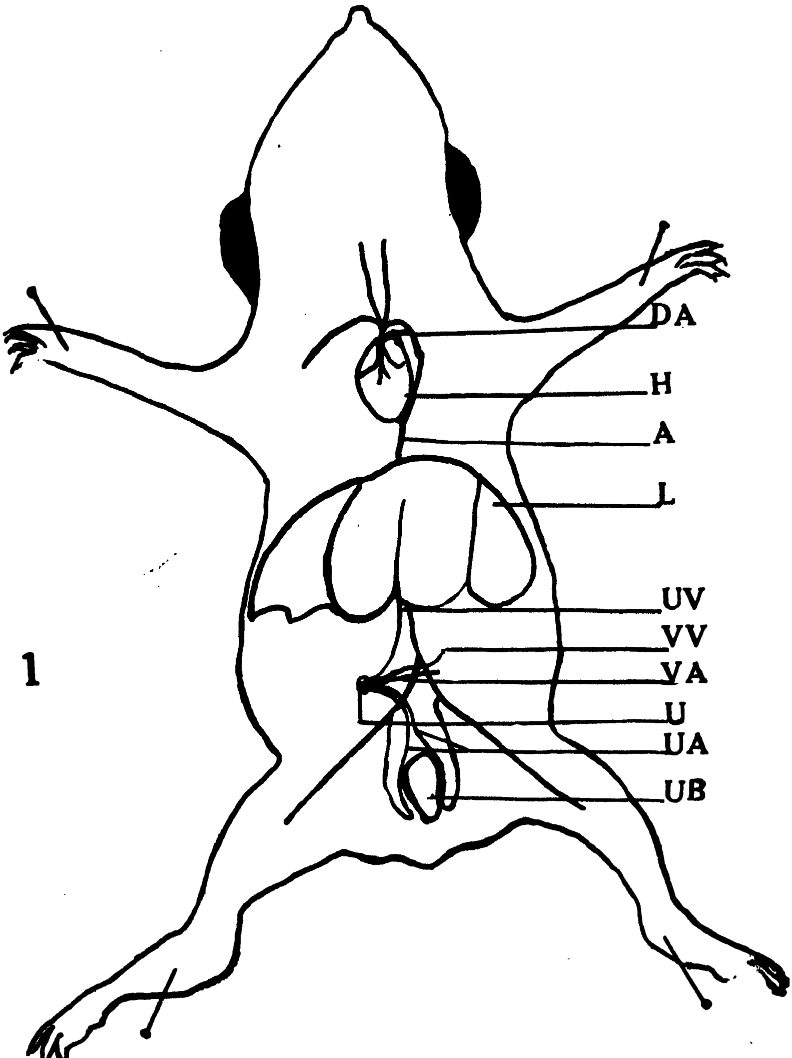


FIG. 1. Diagram showing the blood vessels of the umbilical cord and the ductus arteriosus in the guinea pig. DA, ductus arteriosus; H, heart; A, aorta; L, liver; UV, umbilical vein; VV, vitelline vein; VA, vitelline artery; U, umbilicus; UA, umbilical arteries; UB, urinary bladder.

MATERIALS AND METHODS

In the present investigation 98 guinea pigs were used; 73 were between the ages of one day and three weeks; ten were adults and fifteen were young, born dead. All young were recorded within twelve hours after birth. They were killed at ages varying from one day to three weeks. For injection they were pinned upon a dissecting board (fig. 1). An incision was made along the mid-ventral line of the neck; the skin reflected and the flesh teased away to expose the carotid artery. For the purpose of general dissection and observation of the gross morphology, the left carotid artery was injected with a mass composed of lead chromate, corn starch, and distilled water. For the corrosive and maceration examinations an injection mass of celloidin in acetone was used. The injection fluid was colored differently, depending upon the blood vessels to be injected. Lead chromate was used in the mass for all the arteries and the injections were made through the carotid artery. Aniline blue was used in the portal vein and the umbilical vein and carmine was used in the inferior vena cava. The injected animal was then soaked in water for 20 minutes in order to harden the injection mass, after which the abdominal viscera were removed from the animal and macerated under water. The mesenteries and other tissue were easily separated from the injected blood vessels.

In order to determine the presence or absence of a lumen and its extent in the vitelline blood vessels, the vessels were injected with black India ink by means of a fine glass injection tube. The ability of these vessels to convey blood was determined by forcing the blood contained in them along the lumen of the vessel. When no blood was present the injection fluid was used. This procedure was also employed when investigating the lumen of the umbilical arteries and vein.

In several investigations of the ductus arteriosus an injection fluid of celloidin in acetone, colored with lead chromate, was used to inject the carotid arteries. Aniline blue was substituted for the lead chromate when the external jugular vein was injected. In other investigations of the ductus arteriosus, the hearts, with their accompanying blood vessels, were removed from guinea pigs of various ages. The pulmonary artery and aorta were cut at the point of emergence from their respective ventricles. The carotid arteries and the left subclavian artery were cut, leaving approximately one-eighth inch stumps connected with the aorta; about one inch, more or less, of the aorta posterior to the union of the ductus arteriosus was removed, fixed in Bouin's fluid, imbedded, and sectioned serially. The sections mounted included the ductus arteriosus from the branching of the pulmonary artery to the union of the ductus arteriosus with the aorta.

All measurements of the blood vessels were made with a pair of dividers and a millimeter scale. The drawings were made with the aid of a projection camera and a tracing table.

OBSERVATIONS

The blood vessels examined were the vitelline vein, the vitelline artery, the umbilical vein, the umbilical arteries, the portal vein, the inferior vena cava, and the ductus arteriosus. The bood vessels within the umbilical cord are con-considered together in the order named; the portal vein, the umbilical vein,

and the inferior vena cava and their relations to one another are considered as a unit, and finally the ductus arteriosus is discussed.

THE BLOOD VESSELS OF THE UMBILICAL CORD

At birth the cut portions of the blood vessels within the umbilical cord appear as a blood-clotted stump on the outer abdominal surface of the skin. An area of the external surface of the body wall directly around the umbilical cord, approximately 15 mm. in diameter, is clearly hemorrhagic. This condition begins to disappear during the second day after birth and is lost on the fourth day. The skin of the animal is continuous with the umbilical cord until the sixth day, when there is complete separation. The beginning of this separation is first noticed on the second day, and after that until the sixth day there is a gradual thinning of the connection, which may be broken easily in reflecting the skin away from the body wall.

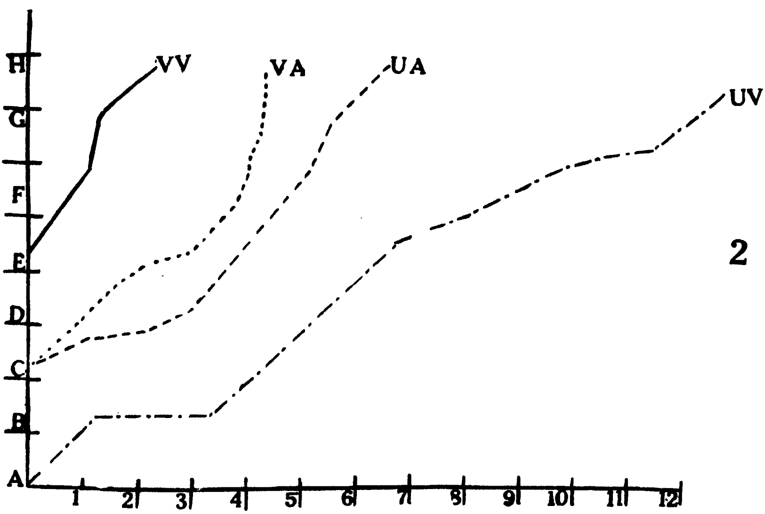
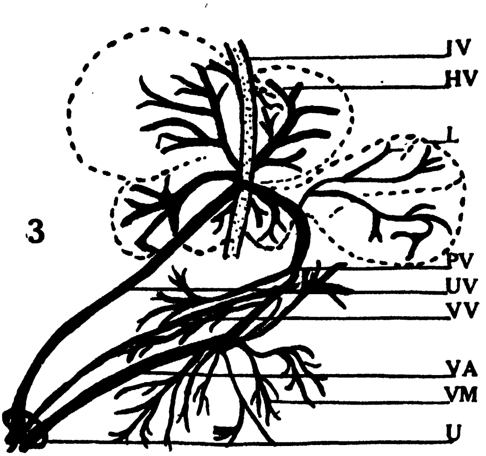


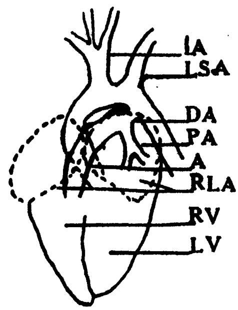
FIG. 2. Graph showing the rates of obliteration of the blood vessels from the umbilical cord in 88 guinea pigs examined between birth and 12 days of life. A, distended with blood; B, full of blood; C, partly filled with blood; D, trace of blood; E, no blood lumen present; F. no lumen present; H, solid cord condition; 1 to 12, days after birth; VV, vitelline vein; VA, vitelline artery; UA, umbilical artery; UV, umbilical vein.

In the following examinations the blood vessels were all observed within the body cavity.

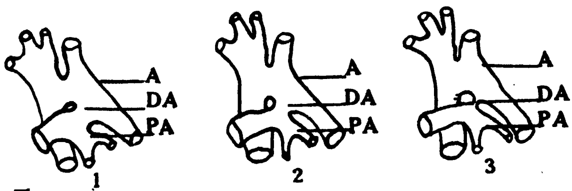
At birth the vitelline vein has little evidence of a lumen while the vitelline artery has a lumen partially filled with blood. The vitelline vein extends for a distance of 20 mm. from the umbilicus into the mesenteries of the small intestine, where it joins the portal vein (fig. 3). The vitelline artery, which is two millimeters shorter than the vitelline vein, enters the mesenteries of the small intestine caudal and dorsal to the vitelline vein. The umbilical arteries

3

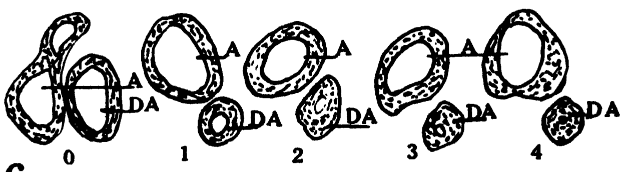




4



5



6

FIG. 3. Diagram showing the relation of the umbilical vein, the portal vein and the vitelline vein within the liver of the guinea pig. IV, inferior vena cava; HV, hepatic vein; L, liver; PV, portal vein; UV, umbilical vein; VV, vitelline vein; VA, vitelline artery; VM, veins of mesentary; U. umbilicus.

FIG. 4. Heart and adjacent blood vessels of a new-born guinea pig. IA, innominate artery; LSA, left subclavian artery; DA, ductus arteriosus; PA, pulmonary artery; A, aorta; RLA, right and left auricles; RV, right ventricle; LV, left ventricle.

FIG. 5. Drawings showing the change in the size of the ductus arteriosus in the first three days after birth. 1, 2 and 3, first, second and third days after birth; A, aorta; DA, ductus arteriosus; PA, pulmonary artery.

FIG. 6. Transverse sections of the ductus arteriosus. 0, 1, 2, 3, 4, day of birth until four days after birth respectively; A, aorta; DA, ductus arteriosus.

have a lumen partially filled with blood, and extend for a distance of 27.5 mm. from the iliac arteries along each lateral surface of the urinary bladder to the umbilicus. In the injected specimens the injection fluid filled the lumina of the vessels for a distance of 18 to 20 mm. from the right and left iliac arteries toward the umbilicus. The lumen of the umbilical vein is much larger than any of the other vessels examined and has a much thinner wall. It is distended with blood for the entire length.

At one day of age the vitelline vein has become a fibrous cord, with no trace of a lumen. The vitelline artery now contains but a trace of blood, which may be forced to flow along the length of the vessel, showing that a lumen is still present. The umbilical arteries contain less blood than at birth and the injection fluid penetrates for approximately half their lengths. The umbilical vein contains a large amount of blood but does not seem distended as much as in the newly born guinea pigs.

In the two-day-old guinea pigs, the vitelline vein has become a solid cord and has lost some of its fibrous condition. The vitelline artery contains a trace of blood which may be forced through only a portion of the proximal end of the vessel. The umbilical arteries contain a lesser amount of blood than the one-day-old guinea pigs, but the injection mass still penetrates about half their lengths. The umbilical vein is filled with approximately the same amount of blood as it contained in the one-day-old guinea pigs. The lumen is sufficiently large to permit rather easy injections.

In the three-day-old guinea pigs, the vitelline artery has no blood in it and only a trace of the lumen is present. The umbilical arteries contain scattered amounts of blood within the proximal half of their lengths. The injection mass penetrates nearly one third their lengths, a distance of 10 to 11 mm. There is no visible difference in the umbilical vein from the preceding stage.

During the fourth day the lumen of the vitelline artery is completely obliterated and has much the same appearance as the vitelline vein in the two-day-old guinea pigs. The umbilical arteries have only a trace of the lumen in the proximal half of the vessels. The umbilical vein contains a lesser amount of blood than it does in the three-day stage and shows signs of fibration at the proximal end which enters the liver.

During the fifth day the umbilical arteries show signs of obliteration and have the appearance of a fibrous cord. The umbilical vein contains only a trace of blood and can still be injected along the entire length.

During the sixth day the umbilical arteries appear as solid fibrous cords, one on each side of the urinary bladder. The umbilical vein has only a trace of a lumen, and successful injections are difficult. The final obliteration of the umbilical vein is a gradual process and does not reach its complete consumation until the twelfth to the fourteenth day, when it appears as a flat fibrous band extending along the inner surface of the body wall.

The vitelline artery and vein, as well as the umbilical arteries, become comparatively cylindrical fibrous cords when their lumina have completely obliterated. Their obliteration begins at the umbilicus and progresses toward the mesenteries and toward the liac arteries, respectively. The umbilical vein, however, begins its obliteration at the proximal end, near the liver, and progresses toward the umbilicus.

THE RELATIONS OF THE UMBILICAL VEIN, THE PORTAL VEIN, AND THE INFERIOR VENA CAVA WITHIN THE LIVER

An examination of the umbilical vein which had been injected with India ink showed a direct connection between the umbilical vein and the portal vein, which persists until the fourth day after birth, when the umbilical vein shows signs of fibration near the proximal end where it enters the liver. There was no direct connection persisting after birth between the portal vein and the inferior vena cava, nor between the umbilical vein and the inferior vena cava. The above relations were shown by the maceration method and the results were equally good when the portal vein was injected instead of the umbilical vein.

THE DUCTUS ARTERIOSUS

There is a rapid functional closure of the ductus arteriosus effective on the third day after birth. The progressive external changes are shown in figure 5 (1, 2, and 3). This functional closure is accomplished first by a constriction of the entire ductus arteriosus, and second by the laying down of a loosely packed mass of connective tissue from its walls. The progressive stages in this internal fibration of the lumen are shown in figure 6 (0, 1, 2, 3, and 4). The constriction is evident on the first day after birth, and becomes more pronounced until the third day, when its size has been reduced to one half of the size at birth. The final anatomical obliteration of the lumen is accomplished in gradual progressive stages until the second or third week, when it has the appearance of a solid cord. This is the condition persisting in the adult animals. The lumen was completely obliterated in most of the animals examined by the fourth day. The exceptions to this condition are: One animal out of twelve examined at five days, one out of nine examined at six days, and two out of seven animals examined at seven days. In these animals a small lumen was present in the ductus arteriosus.

DISCUSSION

The severing of the umbilical cord brings about a functional closure of the blood vessels contained in it. The obliteration of the umbilical blood vessels is a gradual anatomical fibration. The fibration of the umbilical vein differs from that of the other blood vessels in that it starts its fibration at the proximal end and progresses toward the umbilicus, while the other vessels begin their fibration at the umbilicus and progress toward their proximal ends. If, however, we take into consideration the direction of the flow of the blood in the respective vessels it is found that the fibration progresses from the postnatal terminal to the source of blood supply in all of them.

In their investigations of the vascular system of the liver, Mall (1906), Davis (1910), and Ingalls (1908) show the presence of a direct connection of the umbilical vein, the portal vein, and the inferior vena cava by way of the ductus venosus. Scammon and Norris (1918) state in their conclusions that the ductus venosus is the first of the fetal blood passages to be obliterated after birth. In this investigation it was found that the obliteration of the ductus venosus was complete at birth. The connection between the portal vein and the umbilical vein persists until the fourth day after birth, when the umbilical vein shows signs of fibration near the liver.

Before birth there is very little intrinsic circulatory activity in the pulmonary artery, due to the inactivity of the lungs. The pressure, therefore, is nearly equal to that in the aorta. Pohlman (1909) states, "The capacity of the right and left fetal ventricles is equal and the pressure exerted by the right and left fetal ventricles is equal." This condition of equalized pressure in the ductus arteriosus and in the aorta tends to keep the lumen of the ductus arteriosus open and functional. As soon as the lungs begin to function and require a greater supply of blood, with freer flow, the pressure is lessened in the ductus arteriosus. Mall (1906) states, "All vascular channels will disappear in which the rate of the blood stream falls below a certain maximum." Scammon and Norris (1918) conclude that the ductus arteriosus is not obliterated functionally until after 60 days of life. On the other hand, Bryce (1908) states, "The ductus arteriosus is rarely found open after the eighth or the tenth day, and by three weeks it has in almost all instances become obliterated." Our observations on the guinea pig more nearly agree with the early closure and obliteration of the ductus arteriosus. The closure and obliteration begins with the functioning of the lungs and progresses quite rapidly. In all but four of the guinea pigs examined after the fourth day of life the ductus arteriosus was closed and nonfunctional. Arnold (1918), in describing the ductus arteriosus in man, states that there is a "flap-valve-like structure" at the opening of the ductus arteriosus into the aorta. After birth this valve-like structure is supposed to effect the closure of the ductus arteriosus. No such structure was found in the guinea pigs examined.

The conditions of the normal closure of the ductus arteriosus, according to Abbott, as reported by Arnold (1919), depend upon the influences of the changes in the circulation at birth and the changes in the walls of the blood vessels. These changes are mechanical and structural. These changes are so numerous and complicated that the patent lumen existing in the ductus arteriosus after the fourth day in the four cases mentioned above is probably the exception to the normal rate of obliteration.

CONCLUSIONS

1. The process of obliteration of the umbilical blood vessels is a gradual fibration of the lumina of these vessels.

2. The vitelline vein is completely obliterated two days after birth; the vitelline artery by the fourth day; the umbilical arteries by the end of the sixth day; and the umbilical vein is not completely obliterated until the twelfth to the fourteenth day.

3. There is a slight constriction of the ductus arteriosus on the second day after birth which marks the beginning of the occlusion of the lumen of that vessel. This constriction becomes more pronounced by the third day and is one of the important factors involved in the preliminary functional closure of the ductus arteriosus.

4. In most of the animals examined at four days and older, the ductus arteriosus was functionally closed. In all the animals examined after seven days the ductus arteriosus was a fibrous cord.

5. The obliteration of the umbilical blood vessels, with the exception of the umbilical vein, begins with the umbilicus and progresses toward the proximal end of the vessels. The obliteration of the umbilical vein starts at the proximal end near the liver and progresses toward the umbilicus.

LITERATURE CITED

ALEXEIEFF. The foramen ovale in the child. Diss. St. Petersburg. 1900. (From Scammon and Norris, 1918.)

ALVARENGA, P. F. Considerations et observations sur l'epoque de l'occlusion du trou ovale et du canal arteriel. Lisbon. 1869. (From Scammon and Norris, 1918.)

ARNOLD, C. H. A case of probable patent ductus arteriosus in an adult. Jour. Amer. Med. Asc., 72:1673-1675. 1919.

BERNUTZ, (Quoted from Gerard). 1865.

BILLARD, C. M. Traite des maladies des enfants nouveau nes et a la namelle, fonde sur de nouvelles observations cliniques et d'anatomie pathologique faites a l'hospital de enfants trouves de Paris. Paris. 1828. (From Scammon and Norris, 1918.)

BREMER, J. L. Description of a 4-mm. human embryo. Amer. Jour. Anat., 5:459-480. 1909.

BREMER, J. L. On the origin of the pulmonary arteries in mammals. Anat. Rec., 3:334-340. 1909.

BREMER, J. L. The development of the aorta and aortic arches in rabbits. Amer. Jour. Anat., 13:111-128. 1912.

BREMER, J. L. An acknowledgment of Fedorow's work on the pulmonary artery. Anat. Rec., 6:491-95. 1912.

BRYCE, T. H. Quain's anatomy embryology, vol. 1, pp. 1-260. Longmans, Green & Co., New York. 1908.

COULTER, C. B. The early development of the aortic arches of the cat, with especial reference to the presence of a fifth arch. Anat. Rec., 3:578-592. 1909.

DAVIS, D. M. Studies on the chief veins in the early pig embryo, and the origin of the vena cava inferior. Amer. Jour. Anat., 10:461-472. 1910.

ELASASSER. Uber den Zustand der Fotuskreislaufwege bei neugeborenen Kindern. Zeitchr. F. Staatsarzneik., Bd., 64. 1852. (From Scammon and Norris.)

FEDOROW, F. Communications of the Military Medical Academy, St. Petersburg, Russia. 22:No. 1. 1911. (From Scammon and Norris, 1918.)

GERARD, G. De l'obliteration du canal arteriel les theories et les faites. Jour. de l'Anat., T. 36. 1900. (From Scammon and Norris, 1918.)

HUNTINGTON, G. S. The morphology of the pulmonary artery in the Mammalia. Anat. Rec., 17:165-190. 1919.

INGALLS, N. W. A contribution to the embryology of the liver and the vascular system in man. Anat. Rec., 2:338-344. 1908.

KUCHEFF, N. E. The ductus Botalli in children. Diss. St. Petersburg [Quoted from summaries in Jahresber. f. Anat. u. Entwickl., Bd. 7 (N. F.) and from Gindobin: Die Besonderheiten des Kindesalters, 1912.] 1901. (From Scammon and Norris, 1918.)

MALL, F. P. A study of the structural unit of the liver. Amer. Jour. Anat., 5:227-308. 1906.

POHLMAN, A. G. The course of the blood through the heart of the fetal mammal, with a note on the reptilian and amphibian circulations. Anat. Rec., 3:75-109. 1909.

REAGAN, FRANK, The fifth aortic arch of mammalian embryos; the nature of the last pharyngeal evagination. Amer. Jour. Anat., 12:493-514. 1912.

SCAMMON, R. E., and NORRIS, E. H. On the time of the postnatal obliteration of the fetel blood-passages (foramen ovale, ductus arteriosus, and ductus venosus.) Anat. Rec., 15:165-180. 1918.

THEREMIN, E. Note sur l'involution des voies foetales. Rev. d. Mal. d. l'Enfance, T. V. 1887. (From Scammon and Norris, 1918.)

Transmission of Poultry Parasites by Birds With Special Reference to the "English" or House Sparrow and Chickens[1]

WILLIAM LUTHER HOYLE, Bavaria High School, Bavaria, Kan.

Poultry raisers have often suspected the "English" or house sparrow (*Passer domesticus* Linn.) to be transporters of poultry pests from an infested to an uninfested pen, but scientific observations on the subject are brief and somewhat incidental to other studies.

Since ectoparasites of poultry, such as lice, mites, ticks, bedbugs, and sticktight fleas, cause skin irritation, deplumation, and a general rundown condition of the flock, they are of vital interest to poultry raisers and it is important to know how these parasites are disseminated.

A survey of the literature presents evidence that chicken mites and sticktight fleas may be transmitted by the sparrow. These parasites have been reported as occurring on this bird in nature.

According to the literature, Ainslie (1929), Ewing (1922), and Hirst (1916 a) have taken the common poultry mite (*Dermanyssus gallinae* L.) from the sparrow or sparrow nests. Roberts (1930) and Hirst (1916 b) have reported the tropical poultry mite (*Liponyssus bursa* Berlese) as occurring on the sparrow. The northern fowl mite *Liponyssus silviarum* C. & F. has been recorded as taken from the sparrow by Hirst (1916 a) and Rayner (1932). Stewart (1932) as reported that the sticktight flea (*Echidnophaga gallinacea* Westw.) was dispersed by the common sparrow.

Lice, mites, ticks, bedbugs, and fleas are flightless, parasitic arthropods and can live only for a short time away from the host. They are unable to crawl for long distances, and the hosts are thought to be specific. Since large numbers of sparrows often occur about chicken pens, this bird was chosen as the most likely means of transferring these poultry pests from one chicken pen to another.

The "English" sparrow, a misleading name for the house sparrow (*Passer domesticus* Linn.), was introduced from Europe in 1850 and from that time forth has multiplied and become distributed throughout the entire United States. It has become a serious pest about chicken pens, hence it has often been suspected as an agent for dispersal of poultry pests from infested to uninfested pens.

METHODS OF STUDY AND RESULTS OBTAINED

Examination of Birds for External Parasites

Five hundred and sixty-seven sparrows were collected from different habitats, such as in or about chicken pens, in barns, and in wheat fields. The birds were procured by trapping and shooting. The dead birds were examined for parasites immediately after they were killed. Sparrows were found relatively

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. Master's thesis, Entomology Department, Kansas State College, Manhattan, Kan. The author is indebted to Dr. Roger C. Smith, for many helpful suggestions in this research problem.

free of ectoparasites. Less than ten percent of the birds collected were found infested with mites (Analgesidae); 28 were the host of the sparrow mite (*Dermanyssus passerinus*). The common chicken mite (*Dermanyssus gallinae*) occurred on 16 sparrows and *Liponyssus* sp. was found on three of these birds. The sparrow louse (*Degeeriella vulgata*) was found on three sparrows and the chicken body louse (*Lipeurus heterographus*) was found on one sparrow. Other wild birds which are found occasionally about chicken pens were also examined for poultry parasites, but they were free of them, except for the common chicken mite, which was found on the mourning dove.

Examination of Sparrows Nests

Thirty-eight sparrow nests were examined for harboring parasites, of which two nests constructed of chicken feathers were removed from bird houses which were found to be heavily infested with mites fully engorged with blood. Seventeen nests concealed and supported by English ivy vines were removed from the horticulture building, Kansas State College, Manhattan, Kan., on May 25, 1937. *Dermanyssus gallinae* and *Dermanyssus passerinus* occurred in all nests lined with chicken feathers except two. Fourteen of the remaining nineteen nests examined were not lined with chicken feathers and contained no mites; five nests which were lined with feathers were mite free.

PARASITE TRANSMISSION

Direct Transmission

Ten common chicken lice, *Menopon gallinae* L., were carefully removed from a chicken infested with these parasites on February 18, 1937, with a camel hair brush and placed on the feathers of a sparrow to find how long chicken lice would remain on the sparrow. The lice, when placed on the feathers of a sparrow, crawled excitedly over the bird's body in search of concealment. Since sparrows are nervous and excitable, they fly against the cage and kill themselves. In order to prevent flying against the cage, the wing and tail feathers were clipped close to the body. Two lice in this experiment remained on the sparrow for 44 and 46 hours respectively. More than one half of the lice crawled off within 24 hours.

Since the clipping of the wing and tail feathers of the sparrow did not provide normal protection for the lice as occurs in nature, the experiment was repeated on May 10, and again on June 1, with sparrows having wings and tail feathers unclipped. These experiments revealed similar results, except the lice remained on the sparrow for a longer period of time than in the former experiment, due probably to better protection. The maximum time a chicken louse remained on the sparrow in these tests was for 216 hours, or nine days.

Indirect Transmission

Two chickens heavily infested with lice were caged with five parasite-free sparrows on February 17, 1937, to test for transmission of chicken lice from chicken to sparrow by contact or through the dust bath. A dust bath was constructed at one end of the cage in which both chickens and sparrows were observed to dust themselves frequently. The sparrows were examined at intervals of two or three days, but no lice appeared until March 20. Upon examination of the single remaining sparrow it was found to harbor one half-

grown louse, *Menopon gallinae* (L.), along with four minute recently hatched individuals. Empty nit cases were found attached to the feathers on the neck and vent of this bird.

On May 29 the experiment was repeated under similar conditions. Five parasite-free sparrows and two lice-infested chickens were placed in a screened cage about six feet long, three feet wide and three feet high. The ground was loosened so the chickens could make a dust wallow. Upon examination of the sparrows June 1, each bird was found to contain from three to eight chicken lice. Two lice were also found in the dust bath where both sparrows and chickens were observed dusting themselves. On several occasions the caged sparrows were seen sitting upon the chickens' backs. Transmission could therefore have been made also through body contact as well as through the dust bath. The lice remained on three of these birds until the sparrows died five days later. The lice of the two remaining birds were removed for preservation. The experiment was repeated again on June 7, and the lice were found on two of a series of twelve sparrows on June 8.

On February 25, 1937, three sparrows which had chicken lice placed on them were caged about two feet away from two sparrows free of lice. In the meantime the birds possessing the lice had died and the lice had crawled from their bodies and three of them were found on the body of a parasite-free sparrow. The lice evidently left the dead birds and sought the sparrows in the other cage for body warmth and protection.

Eight sparrows were captured at Winfield, Kan., February 1, 1937, and were shipped to the writer at Manhattan, Kan. for examination. The sparrows had been examined previous to shipment for lice and were found lice-free. Chicken lice (*Lipeurus heterographus* N.) were placed on the sparrows and in the box in which they were shipped. When the sparrows arrived they were examined. One sparrow was living and the remaining seven were dead. The living sparrow had nine living lice on its body, and one of the two dead sparrows had two living lice and the other bird three on it. The examination was made two days after the lice were transferred to the sparrow.

Chicken Lice Longevity Separated from the Chicken as Host

Chicken lice have remained on the sparrow as host for 216 hours, or nine days, as previously indicated.

On February 18, 1937, a vial of 25 lice, *Menopon gallinae* (L.), were used in an experiment in which the lice were kept secluded from a host. A freshly plucked chicken feather was placed in the vial for the lice to feed upon. The vial was carried in the vest pocket of the experimenter in order to maintain a more or less constant temperature, which was about 94° F. All of the 25 lice died within 27 hours. More than half died at the end of the twelve-hour period.

The experiment was repeated on May 10, and June 1. Seventy-two hours was the maximum time in which the lice lived in a vial with the feather. More than one half died between eight and sixteen hours.

Chicken Lice Placed in a Vial of Dust

Twenty-five chicken lice were placed in a vial of dust on February 18, 1937, and were carried in the vest pocket of the experimenter. All of the twenty-five lice died within five hours after the time they were placed in the vial of

dust. The experiment was repeated on May 10 and June 1. On May 10 six of the lice died at the end of the five-hour period, but seventy five percent died within twelve hours. The same results were obtained on June 1. The maximum length of time that a louse was kept alive in a vial of dust was 27 hours.

Chicken Lice Placed in an Empty Vial

Twenty-five chicken lice were placed in an empty vial on February 18, and were also carried in the vest pocket of the experimenter. Nearly fifty percent of the lice died within twelve hours, and all died within nineteen hours. The experiment was repeated on May 10, and June 1. In these experiments 50 percent of the lice died within 12 hours, and all 25 lice died within 31 and 30 hours, respectively.

Chicken Parasites Found on the Sparrow in Nature

On August 21, 1936, a sparrow was shot from the fence of the chicken pen, and a single louse, *Lipeurus heterographus* N., was taken from the under surface of the wing feathers. The chickens in the pen had been examined at intervals previous to this time and were found free of lice. On September 11, 1936, when the chickens were again examined, a rooster and two hens of a flock of nine were found to have a small number of chicken lice. The chickens were penned and no new individuals were introduced into the flock. Since the chickens were penned and no new individuals were introduced, it may be safely presumed that the lice were transferred to these chickens by the common sparrow through the dust bath.

Since both chicken lice and chicken mites have been found on the sparrow under natural conditions, it may be assumed that it is possible for the sparrow to act as intermediate host in transferring lice and mites from a flock infested with these poultry pests to one uninfested.

External Body Temperature of Chicken and Sparrow

The external body temperature of the birds was taken by placing a fever thermometer under the thigh. The thermometer was held in position for three minutes to obtain accurate and uniform readings. The temperatures were taken each day for a ten-day period during two different seasons, and an average temperature was obtained for each fowl. The purpose of this experiment was to see whether the external body temperature of a chicken was the same as that of the sparrow. If the temperature of the sparrows and chickens do not differ much, it would likely indicate that the lice of chickens could survive on sparrows.

The average temperature for eight chickens for 80 readings was 104.74° F., while the average temperature for ten sparrows for seventy-one readings was 104.83° F. The difference between the temperatures is believed to be inconsequential.

Dust Baths as a Source of Lice Infestations

Upon a number of occasions chickens were observed wallowing in a dust pit, and shortly after sparrows appeared at the same pit to dust themselves. It is probable that the chickens shake lice from their feathers into the dust. Shortly after, sparrows wallowed in the same dust pit, and it is probable that the lice crawled on the sparrows for warmth and concealment. In experi-

ments it was observed that chicken lice which had been shaken into the dust pits clung to the feathers of the sparrows with great fervor.

During the month of August, 1936, sparrows congregated in large numbers about chicken pens where the chickens were feeding. They were often seen wallowing in the dust pits where the chickens dusted themselves frequently. Sparrows were often seen dusting themselves in the same pits.

As dust baths are known to have insecticidal value, the lice being unable to withstand large quantities of dust, are shaken from the chicken's body into the dust pits. In order to get the necessary warmth and protection it is probable that the lice cling to the sparrows when chances afford an opportunity for them to do so.

The evidence at hand indicates that the common "English" or house sparrow is a source for transmission of poultry parasites such as mites, lice, and sticktight fleas from an infested flock of chickens to one noninfested.

SUMMARY AND CONCLUSIONS

The following conclusions are indicated by these observations:

1. Chicken lice have lived for nine days on the "English" or house sparrow, which period is long enough to permit transmission of lice from one flock of chickens to another.
2. Chicken lice have been found to reproduce on the sparrow, as the nits and empty egg cases were found on them.
3. Eight parasite-free sparrows have become infested with chicken lice by contact with chickens or through the dust bath on three different occasions.
4. Lice have been kept on the sparrow for a maximum of 216 hours.
5. Chicken lice placed in a vial with a freshly plucked chicken feather lives a shorter time than on the sparrow as host, and lice placed in an empty vial died on an average within twelve to nineteen hours.
6. Chicken lice shaken in a dust bath and permitted to wander at random in a vial died on an average within seven hours, which indicates that the dust is injurious to lice.
7. The external body temperatures of the sparrow and the chicken are so nearly equal that the chicken lice possibly seek the sparrow as well as the chicken for protection and body warmth.
8. The dust bath is a probable source of infestation of the chicken lice by sparrows and they transmit them from one fowl to another.
9. The body chicken louse (*Lipeurus heterographus* N.) was found on the sparrow in nature.
10. The common chicken mite (*Dermanyssus gallinae*) was found to occur on sixteen sparrows, and the feather mite of poultry (*Liponyssus* sp.) was found on three of these birds.

BIBLIOGRAPHY

AINSLIE, C. N. Note on the occurrence of the mite *Dermanyssus gallinae* L in the nest of a house wren. Canad. Ent., 61:39-40. 1929.

EWING, H. E. The dermanyssid mites of North America. Proc. U. S. Nat. Mus., 1, 26 p. 1922.

HIRST, S. (a) Notes on parasitic Acari. Jour. Zoöl. Research, 1:59-89. 1916. (b) On the occurrence of a tropical fowl mite (*Liponyssus bursa* Berlese) in Australia, and a new instance of its attacking man. Ann. Mag. Nat. Hist., 18(104):243-244. Aug., 1916.

RAYNER, J. A. Parasites of wild birds in Quebec. Sci. Agr., 12:307-309. 1932.

ROBERTS, F. H. S. A poultry mite infesting dwellings. Queensland Agr. Jour., 34:595-596. 1930.

STEWART, M. A. Dispersal of the sticktight flea of hens (*Echidnophaga gallinacea*). Jour. Econ. Ent., 25:164-167. 1932.

The Social Hierarchy in Albino Mice

JACOB UHRICH, the University of Chicago, and Kansas State Teachers College, Pittsburg, Kan.

ABSTRACT

Daily observations of the social behavior of more than 300 male and approximately 150 female white mice, arranged in 85 groups of various sizes and composition, yielded the following results:

1. Fighting was very common among males, but relatively rare among females or between the sexes.

2. The most common type of social order found among the males was exclusive domination of the group by one individual. Occasionally several other distinct kinds of hierarchies were recognized.

3. Permanence of a given order lasted from a few days to several months.

4. The amount and severity of fighting varied considerably in different groups and in the same pen at different times.

5. Among adult males little or no correlation was apparent between the social order and such factors as weight, age, and reaction to females.

6. Blinding did not seriously interfere with the fighting behavior, while castration seemed to decrease the pugnacious tendencies of some, but not all males.

7. Fighting began among males on the average at the age of 50 days and either gradually or abruptly gave rise to a definite hierarchy.

Trans. Kansas Acad. Science, Vol. 41, 1938.

An Attempt at an Ecological Evaluation of Predators on a Mixed Prairie Area in Western Kansas[1]

L. D. WOOSTER, Fort Hays Kansas State College, Hays, Kan.

The present study is an attempt to evaluate certain animals in terms of their importance to the general animal community on a mixed-prairie area in midwestern Kansas. Such a study has both biological and economic values. The problems of conservation, game management, predator control, and rodent control can be solved with any degree of satisfaction only as we gain as full an understanding as possible of the biological, and, especially, ecological status of animal and plant life on any given area.

At the same time, such a study is of importance to our understanding of certain phases of life and its relations to environment. With these problems, both economic and biological in mind, a study has been and is being made of the ecological place of certain mammals and birds on a mixed prairie area involving particularly the relations of predatory mammals and birds to the mammals which are commonly preyed upon. This paper is a report of that part of the study which deals with the predators.

By "ecological evaluation of predators" is meant an attempt at determining their relative importance in the scheme of things, that is, to one another and to the animals on which they prey. The factors entering into this matter of importance are food, numbers and time. In other words, the animal importance of any species (coyote, for example) to other species of predators and to the various species preyed upon depends largely on the amount of food which a single coyote eats per day, multiplied by the number of coyotes present on a given area, say a square mile, multiplied by the number of days in a year that the coyote is present on that area. The product of these three factors, compared with the product of the same three factors in the case of each of the other predatory species, will give the relative importance of the coyote on such an area. It is therefore necessary to obtain data on these three factors, namely, food requirements per individual, number of individuals per square mile, and the portion of the year present.

The study was made on a square mile of mixed prairie in Ellis county, Kansas, two miles west of Hays. The land on which the study was made is state land under the management of the Fort Hays Kansas State College. The study was made from the years 1930 to 1936. The predators which were found by the study to be numerous enough and important enough as predators on mammals to be included in the study, were: the coyote, *Canis nebrascensis nebrascensis* Merriam, the marsh hawk, *Circus cyaneus hudsonius* (Linnaeus); the Swainson hawk, *Buteo swainsoni* (Bonaparte); the American rough-legged hawk, *Archibuteo lagopus sancti-johannis* (Gmelin); the ferruginous rough-legged hawk, *Archibuteo ferrugineus* (Lichtenstein); and a miscellaneous group of hawks and owls. Badgers have become too nearly exterminated to play an

---

Trans. Kansas Acad. Science, Vol. 41, 1938.

1. The writer wishes to acknowledge the helpful suggestions and painstaking criticisms of Dr. Willis H. Rich, of Stanford University, during the work of this study and the preparation of this paper.

important part. Skunks are numerous, but are so largely insectivorous that they play only a very minor part in the interrelations here studied.

No records of the sort of study here attempted have been found in the literature. Some such studies have been made on insects, and a number of surveys of animal numbers have been made, but as far as has been ascertained there have been no attempts made to evaluate the higher vertebrates.

It will be noted that the predators here studied are those about which there is most concern among farmers, hunters, conservationists, etc. There is considerable lack of accurate information on these animals and their food habits, and there is much misinformation concerning them.

By mixed-prairie area is meant that region in west central Kansas north of the Arkansas river in which the short grass area of the extreme western part of the state and the tall grass area of middle and eastern Kansas overlap, so that there is a mixture of areas of short grass, meaning buffalo and grama grasses, on the one hand, and tall grass, by which is meant little bluestem, on the other hand. This mixed prairie is typical of 18 or 20 counties.

BIRDS-OF-PREY POPULATION

The species of birds of prey present on mixed prairie, and the numbers of each species at all times of the year, were determined by three methods:

(1) By 113 one-individual observation trips to the area of study, distributed through all the months of the year (1930-'31); (2) by 12 transect surveys, one per month for twelve months (1932-'33) with the help of from eight to thirty people per trip; (3) by a special study of hawks' nests through two summers (1932 and 1933).

There were certain limitations to the accuracy of the study. For instance, in arriving at the field, a hawk on the far side of the area might be seen and recognized as a hawk, but yet be too far away for species identification. In coming onto the area of study it was doubtless often true also that hawks were present which were not seen at all, because they were on the ground or sailing low over the ground on parts of the area which were invisible to the observer. Furthermore, it was not possible to make exact counts of the owls, for the reason that they were usually hidden in the daytime and impossible of more than occasional observation in the darkness of night, the time of their activity.

It will thus be seen that the number of birds of prey as observed would be a minimum, and presumably less than the actual number present on the area.

There were 4.7 marsh hawks; .17 rough-legged hawks (2 species); 1.7 Swainson hawks; .21 unidentified hawks and owls; or an average of 6.8 "birds of prey" of all kinds present on the area per day for one year. The marsh hawk composed more than half of this average. In other words, there were more marsh hawks present than all the other species of "birds of prey" combined.

There were not only more adult hawks present in the summer than in the winter, but in addition there were the young, which increased the total several times. The average daily number present for the period including the months of September, October, November, December, January, February and March, was 1.8; for the period including April, May, June, July and August, it was 10.

COYOTE POPULATION

In order to make a count of the number of coyotes present on a square mile of mixed prairie it became necessary to use an entirely different method from that used in counting any of the other animals. Trapping would be entirely unsatisfactory. Transect-surveys over large territory, participated in by a large number of people and repeated in the four seasons of the year, might yield fair results, but would involve practical difficulties which would be prohibitive. However, there appeared to be a method, which, while it involved some uncertain elements, such as illegitimate bounty collection, would yield data en masse of greater accuracy than any other.

This method consisted of a study of the coyote bounty records in Ellis and other Kansas counties of the mixed-prairie area. The state of Kansas has had on its statute books, almost from the beginning of the organization of counties, a law requiring counties to pay a bounty of one dollar per coyote scalp brought in to the county clerk from the confines of the county. The records of these bounties in Ellis county are available for nineteen years preceding 1933, and in some counties for even longer. A comparison of the records from different counties showed that the Ellis county records are typical, and since the study of other animal populations was being made in Ellis county, it was desirable to use the coyote bounty records therefrom also.

TABLE 1.—Coyote bounties in Ellis county, Kansas, for 19 years.

Year	No.	Year	No.
		1923	381
1914	237	1924	324
1915	300	1925	325
1916	323	1926	301
1917	541	1927	264
1918	402	1928	280
1919	274	1929	245
1920	257	1930	441
1921	247	1931	418
1922	459	1932	355
Arithmetic mean for nine-year period (1914-22)			338
Arithmetic mean for ten-year period (1923-32)			333.4

A study of this table shows that the arithmetic mean of bounties paid per year on coyotes in the ten-year period from 1923 to 1932, inclusive, is 333. For the preceding nine years (the tenth year back is incomplete) the arithmetic mean is 338.

It will be seen from the above data that the average for each of the two periods is practically the same. This would indicate that coyotes have held their own in numbers through a period of almost twenty years. If coyotes were either decidedly on the increase or decidedly on the decrease the fact would, over a considerable period of time, be manifest in the numbers killed for bounty. Neither seems to be the case. It is of interest to note that the common impression among old settlers, farmers and hunters is to the effect that coyotes are maintaining their numbers in spite of the number killed for bounty. This impression corresponds to the indications of the bounty records.

The bounty records do show short cycles of increase and decrease. Whether these increases and decreases represent changes in abundance or in the amount

of hunting done in different years need not be determined for the purposes of this study. The point is, that in spite of these short cycles of variation in the number of coyotes brought in for bounty collection, over a considerable period the "peaks" and "valleys" in the figure approximately balance, and the average number of coyotes remains remarkably constant.

The above fact is of importance for the purpose of determining the number of coyotes in the county, for, if the number of coyotes remains fairly constant then those brought in each year for bounty collection represent each year's increase. For instance, if there are 333 animals killed one year, and the next year approximately 333 more are brought in, and the next year the same and so on, it is evident that there are enough coyotes remaining alive each year to produce that many offspring the next year. If, then, the number brought in each year represents the increase, what is the number of parents necessary to produce this number of offspring?

In order to answer this question the county clerk of Ellis county, Kansas, was asked to keep a record of the number of young in each litter brought in for bounty collection during one spring (1931). It should be explained that in the spring it is comparatively easy to obtain whole litters of coyote young by discovering the den, then digging out the entire family and presenting them for bounty collection. Twenty-eight litters were presented for bounty collection in the spring of 1931. The numbers in these litters were, respectively: 9, 7, 8, 12 (possibly two litters), 5, 5, 8, 4, 8, 5, 8, 5, 3, 5, 5, 6, 7, 4, 3, 4, 6, 8, 7, 5, 8, 7, 8, 4. The total is 174. The number per litter, by the method of arithmetic mean is $6.14 \pm .28$. Each year's increase, namely 333, then would represent 333 divided by 6.14, or 54 families (pairs of parents), or 108 individuals. These 108 individuals would form the "permanent" population of the county.

The total number of coyotes present in the county, then, during the year would be the sum of 328 and 108, or 436.

But of these 436 coyotes 328 are not present *throughout* the year. They represent more than the effective annual "working force" of coyotes in the county. Many of them are removed from the population in the first month of their existence; many more are removed in the second month; and they continue to be removed from month to month throughout the year. By "annual effective working force" is meant the average daily number living and consuming food throughout the year. One adult coyote living for one year and consuming a normal amount of food from among the animals of the mixed-prairie represents a unit of coyote "working-force," for the purposes of this study. Since the 436 coyotes present during the year do not represent that many actual, annual coyote-units it becomes necessary to translate that number into its equivalent in effective, annual units.

Of the total number of coyotes present in the county during any year, only about one third, then, actually live throughout the year. The other two thirds live for periods of time which range from a few days to several months. From the coyote bounty records it is possible to determine how many of these lived approximately one month, how many two months, how many three months, and so on. But before the final coyote values are determined one other factor should be mentioned.

A young coyote, at least for the first few weeks of its existence, does not consume an adult coyote's daily ration of food, and therefore is not a whole coyote unit in its effect on the animal life of the prairie. While this is not a large factor, and can be determined only roughly, it may be at least partially compensated for by omitting from the total number those captured in litters during the first three months of their existence. Approximately an equal number of young lived at least until they were grown. If it is assumed that the food consumption of a young coyote (both before and after birth) is about half that of a grown coyote, then by omitting half the young from consideration as far as numbers are concerned, but including them as far as food is concerned, their food consumption would balance that of the other half in terms of adults.

With the foregoing considerations in mind the total coyote units on the mixed-prairie were determined.

In the year 1932, the year used for the counting of animals of the different species in this study, there were 355 coyote bounties paid in Ellis county, Kansas. These 355 coyotes lived only parts of a year each. According to the records of coyote litters, as kept the previous year by the county clerk, 41 percent, or 146, of the coyotes brought in for bounty collection were in the form of litters. As previously suggested, if we eliminate these from further consideration, the remainder, 209, were captured as mature coyotes at some time during the year, each living some fraction of a year. The sum of these fractions of a year divided into year units will give the equivalent in coyote-year-units found among the 355 coyotes.

Column 2 of table 2 shows the number of coyotes captured in each month of the year 1932. Column 3 shows these same numbers, but with the young,

TABLE 2.—Coyotes caught (minus litters) in 1932 changed to coyote-years

1	2	3	4	5
MONTH.	Bounties,	Bounties, minus litters.	Number of days each lived.	Total days.
January	28	28	285	7,980
February	9	9	315	2,835
March	7	7	345	2,415
April	75	27	15	405
May	90	30	45	1,350
June	41	15	75	1,125
July	20	7	105	735
August	2	2	135	270
September	6	6	165	990
October	21	21	195	4,095
November	26	26	225	5,850
December	30	30	255	7,650
Totals	....	208	....	35,700=98 yrs.

as captured in litters, subtracted. Column 4 shows the number of days each coyote lived. (Each coyote is counted as having lived from the beginning of the coyote year, April 1, when the young begin to appear, to the middle of the month in which it was killed and brought in for bounty collection.) Column 5 shows the total number of days represented by the coyotes that lived to the middle of each month. The sum of these days represents the total number of coyote-days lived during the year by the "temporary" population. The total "coyote-days" divided by 365 gives the number of "coyote-years." By "coyote-year" is meant the equivalent of one adult coyote living for one year.

35,700 coyote-days is the equivalent of 98 coyote-years, or the equivalent of 98 adult coyotes living and consuming food for one year among the 355 partial units. These 98 coyote-units added to the 116 "permanent" residents, are 214 annual-coyote-units in Ellis county for the year 1932.

Ellis county contains 900 square miles, of which 406 are mixed-prairie, according to records on file in the county clerk's office, The mixed-prairie land, with its tall and short grass, its gullies, rocky ledges and its animal life of rabbits, rodents and birds is the natural habitat of the coyote.

If, then, there are 406 square miles of mixed-prairie in the county, and the equivalent of 214 coyotes living on these 406 square miles throughout the year, there are approximately .5 coyotes per square mile on mixed-prairie land in Ellis county.

The following table shows the average daily number of predators on one square mile of mixed-prairie:

Coyotes	0.5
Marsh hawks	4.7
Swainson hawks	1.74
Archibuteos	0.17
Miscellaneous "birds of prey"	0.21

THE FOOD CONSUMPTION OF PREDATORS

Since it is impossible, in the very nature of the case, to determine accurately the amount of food eaten by predators in their wild state, it becomes necessary to use other means for that determination. Information as to their natural food consumption is most nearly approached by that obtained from the carefully studied and controlled dietaries used in some of the large zoölogical parks of the country. Consequently, the directors of two of the large parks were asked for such information. The New York Zoölogical Park (Leister, 1931) kept careful records for two weeks in order to make reply to the request for such information. The Philadelphia Zoölogical Garden (Brown, 1932) already had on file the desired information.

In the New York park the hawks and owls are fed, on the average, 227 grams per individual, per day, for five day a week, or 162 grams each per day for a seven-day week. In the Philadelphia Garden these birds are fed 113 grams per individual, per day, for six days a week, or 97 grams per day for a seven-day week. The arithmetic mean of the daily feeding by the two parks is 130 grams. The food requirement of one of these birds of prey for one day, then, is 130 grams: for one year 47,450 grams.

The coyotes in the New York park received 680 grams per day, per individual, four days a week, or the equivalent of 389 grams per day for a seven-

day week. In the Philadelphia Garden a coyote receives 1,134 grams per day, seven days a week. The arithmetic mean of the feedings of the two parks is 762 grams per day, and for one year, 287,130 grams.

It will be noticed that the amounts of the feedings in the two zoölogical parks are considerably at variance in the case of both the birds and the coyotes. The directors of both parks report that the animals are fed the amounts which seem to keep them in the best possible condition. The animals have a considerable amount of freedom, though of course not as great as that of wild animals. From that viewpoint they probably do not need as much food as wild animals. On the other hand, the wild animal probably does not always obtain as much food as it would eat if it had it. In any case, the averages of the feedings in the two parks are the best information available and can be used with the assurance that they at least roughly approximate the correct food requirements of the animal concerned.

In summary, the predators require per individual daily, throughout the year, estimated amounts of food as follows:

Coyote	762 grams
Hawks, owls	130 grams

TIME RELATIONS

The predators are of importance in terms of time in proportion to the part of the year in which they are present and active. The coyote is present and active throughout the year. This fact is known by common observation and by the bounty records. The marsh hawk is present and active throughout the year. The two species of rough-legged hawks and the Swainson hawk are each present through five months of the year only. The remaining miscellaneous species of birds of prey are present for various periods. All the foregoing facts were obtained by field observation.

EVALUATIONS OF PREDATORS

FORMULA: $F \times T \times N = RI$

"F" is food per day in grams; "T" is time—fraction of a year; "N" is numbers per square mile; "RI" is relative importance.

Coyote	$762 \times 1 \times 0.5 = 381$
Marsh hawk	$130 \times 1 \times 4.7 = 611$
Swainson hawk	$130 \times 1^* \times 1.74^* = 226$
Archibuteos	$130 \times 1^* \times 0.17^* = 22$
Other hawks and owls	$130 \times 1^* \times 0.21^* = 27$

From the foregoing, then, it is found that the marsh hawk is the most important predator on mixed-prairie, with a score of 611. The coyote stands second, with a score of 381. The Swainson hawk stands third, with a score of 226. The Archibuteo stands fourth, with a score of 22, and the other hawks and owls, all together, have a score of 27.

These "scores" are really grams of food consumed per day by each species. They (the scores) show the relative importance of the various species of predators to each other as competitors for the same food. And they also show the relative importance of the different species of predators to the animals preyed upon. To express the matter in terms of annual importance the marsh

* Time factor already figured in.

hawk is of 221,555 food-grams importance; the coyote is of 139,065 food-grams importance and the Swainson hawk is 82,490 food-grams importance to the animals of the area per year.

The annual food importance of the marsh hawk, expressed in avoirdupois weight is 494 pounds, or almost one fourth ton. In terms of meadow mice the marsh hawks on one square mile would require sixteen mice per day, or 5,840 per year. The coyotes on one square mile (one half an animal), if they ate nothing but jackrabbits, would require 45 per year. To supply the annual needs of all dominant predators on one square mile of mixed-prairie would require, for example, 150 jackrabbits, or 12,000 meadow mice, or 50,000 harvest mice.

It is not the purpose of this study to enter into a discussion of the applications of the results of this study to biological or economic problems, but it will readily be seen that there are important implications involved for such matters as balance, struggle for existence, natural selection, predatory animal control, rodent control, game management, etc.

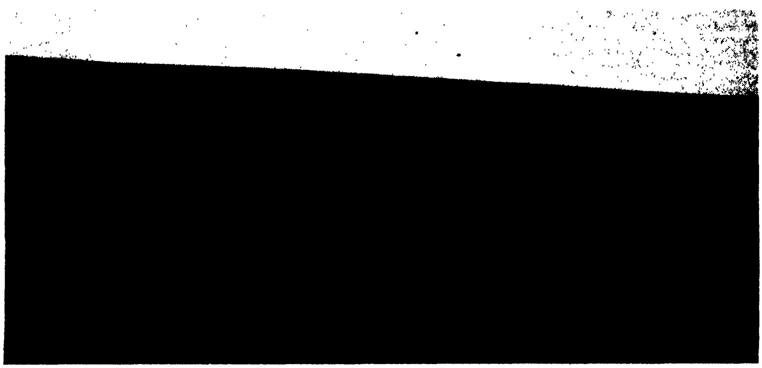


FIG. 1. An area of mixed prairie.

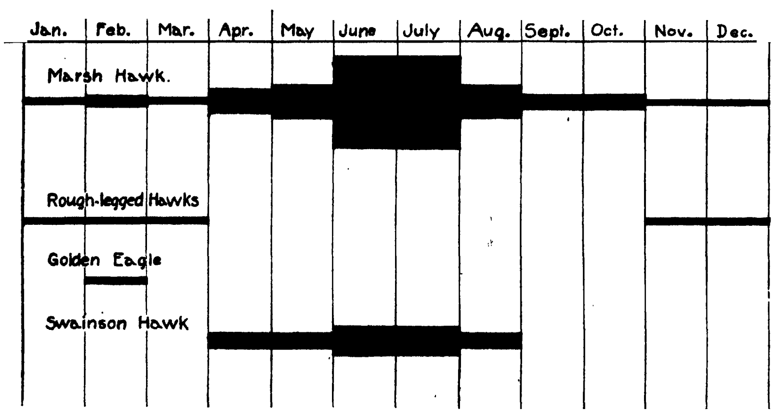


FIG. 2. Number of hawks per month on one square mile.

The Preparation of Drawings and Photographs for Reproduction in the "Transactions."

W. J. BAUMGARTNER, University of Kansas

Children of today are constantly seeing picture shows. They are learning more and more of their facts through their eyes. The general public is rapidly learning to depend very largely upon pictures for absorbing the events and news of the world. This fact is proven by the almost immediate popularity of pictorial weekly publications, such as "Life," "Look" and others. Every one of our daily papers is using two or three times as many pictures as they did even five years ago. To us as scientists and educators these changes can mean only one thing; that is, we *must* use more and better illustrations in our science textbooks and in the publishing of our researches. If we must use more and better pictures, then it behooves us to learn more about good plate making.

In spite of the fact that the editorial board printed rather extended directions for the making of drawings and photographic plates for use in our "Transactions," in volume 39, the drawings and photographs received for volumes 40 and 41 convince the managing editor that additional statements about good and bad illustrations will improve our publication. Those who studied the drawings with the illustrations of reproductions displayed at Pittsburg got the import of the following statements very effectively. But since the paper could not be read about the display because of lack of time, this paper is published, hoping thereby to show further details of good drawings and photographs.

To understand the difference between the right kind and wrong kind of drawings should help everyone to offer only the better kind to the engraver.

The most frequent mistake in regard to drawings is the preparation of "artistic," that is, fine lined and fine stippled drawings. They look beautiful to instructors and are likely to get the best grades in courses. They do not satisfy the engraver, however, because the fine lines and dots do not show up in zinc reproduction. Crowded fine dots produce solid black and scattered fine dots disappear. This is well illustrated by the plate on page 227, vol. 40. The drawing was beautifully done. The shading was nicely graded by crowding or scattering the fine dots. But as you see, especially in figures 18 and 19, the crowded dots produced solid black and the widely scattered dots disappeared, leaving certain parts of the areas pure white.

Another objection to this drawing is that it was much too large, requiring reduction to one fourth of its size. The individual drawings are also mounted much too far apart for reproduction, although they look much more artistic mounted thusly; but they are wasteful of too much space. Had they been crowded together they would have required only one half reduction and all parts, including figures, would show much better.

Another plate might be worth studying, namely page 154, vol. 40. Note

Trans. Kansas Acad. Science, Vol. 41, 1938.

that the lines are all sharp and even. The dots show the different shadings and the figures are clear and of proper size. When first presented this drawing was just page size, beautifully shaded with very minute dots and all the lines hairlike. Any professor would have graded the drawing "most excellent." The managing editor advised a redrawing, twice the size, with coarse dots and rather heavy lines. The second drawing gave this fine plate.

A second satisfactory drawing is reproduced on page 337, vol. 40. The drawing was coarse, the lines heavy and the whole did not look very beautiful. But the plate is quite satisfactory.

The following brief suggestions are offered. When starting your illustrative black-line drawing decide upon the size you want. That is, the size that you want the illustration to appear upon the printed page, then make the drawing two (or possibly three) times as large. Make all border lines and shading lines and all dots heavy, using India (not fountain pen) ink. The larger your drawing is with regard to the final print the heavier your lines and the larger your dots should be. Make or select your labeling figures so that after reduction they are of suitable size.

About mounting drawings into groups for plates, it is best to observe the following rule: If the drawings are repeatedly referred to in the text, especially in different parts of the manuscript, then the illustrations are best placed on a page at the end, *i.e.*, into a plate. If an illustration is referred to only once, or possibly twice, then the figure is better placed near the reference in the text. (A group of single figures costs the academy more than the same figures in a plate.) In assembling a plate follow the directions given in vol. 39. Do not crowd the drawings too much. Yet, on the other hand, do not scatter them too much, thus wasting space and increasing unduly the cost of reproduction. In labeling use figures of a size that will be readable when reduced by the engraver. (See the waste space on pages 227, 257, and 393, vol. 40.)

In drawing graphs, be sure to select cross-ruled paper with lines coarse enough to show and not break down in reproduction by the engraver. Fit the size of your graph to the paper selected, or vice versa. In the graphs shown (on page 214, vol. 40) notice the broken down cross-rulings, particularly in the middle graph, reduced four times. Such graphs will always look ragged. Better ruled paper or less reduction would help much. Clearly ruled paper with properly sized graph lines will produce a much better looking picture.

In producing and using *photographs* make photographs show good contrast in lights and shadows. Take them of such size that they will *not* need much reduction or *much* increase in size for the printed page. Photographs should be mounted so that they almost touch, leaving only a narrow line, and the engraver will then cut a narrow groove between them. (See the illustrations on pages 93 and 99 in vol. 40, in which the engraver cut a clean, narrow groove between photos which were mounted fairly close together with somewhat uneven edges.)

All photographs should bring out all the contrast of colors which is possible. They should be printed on glossy paper and they should be mounted onto plates.

It is anticipated that in the future volumes of the "Transactions" it will be possible to have much better paper (more strongly sized paper) used for a series of copperplates, that is, plates made to reproduce photographs. So if you are contemplating a paper which has a series of photographs as illustrative material it will be well worth your effort to produce only the best and most useful plates. Before starting your photographing read again the "Suggestions" at the end of vol. 39. If wanting still more information, seek some good book on photographing for scientific reproduction, or write the managing editor.

The Kansas Academy of Science—Past, Present and Future

W. H. SCHOEWE, University of Kansas, Lawrence, Kan.

INTRODUCTION

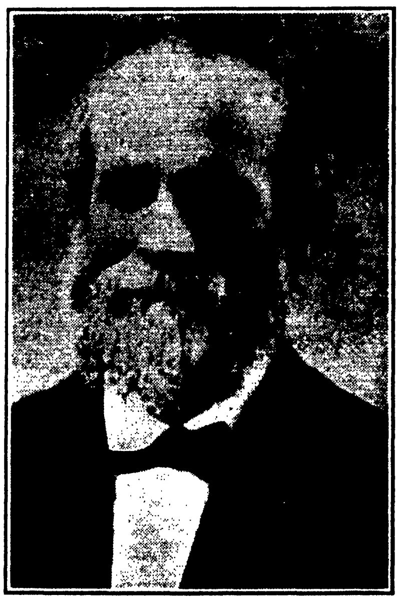
With the exception of 1915, the Kansas Academy of Science has met every year since 1868. Our annual meeting this year, therefore, marks the seventieth one in its history, a history we can well be proud of and one with which are associated the names of all Kansas scientists of note. The adoption of a new policy, namely, the electing of the Academy president a year before taking office, at our last annual meeting at Manhattan marks another important milestone in the growth and development of the Academy. As president-elect, I thought it might be well for me and for the benefit of the Academy to take advantage of this new policy. With a year before me in which to give attention and thought for the welfare of our Academy, it occurred to me to take at least a partial inventory of our activities in order to better plan the affairs of the Academy for the year of my administration. Furthermore, I was of the opinion that such an inventory might be of interest to our younger members who may not be acquainted with the history of our organization. The past history of the Academy has been the theme of a number of past-presidential addresses (1) and academy papers (2). I shall, therefore, not repeat in detail what is already in print. I do wish, however, to outline briefly the more important events in the development of this Academy.

IMPORTANT EVENTS IN THE HISTORY OF THE ACADEMY

The founders of the Kansas Academy of Science were J. D. Parker and B. F. Mudge, whose pictures are shown herewith. In 1867, Professor Parker was elected to the chair of Natural Science at Lincoln College, now Washburn, at Topeka. Coming from the east where scientific groups and activities were more fully organized, Parker soon discovered that in Kansas science was not much in the forefront, that there was no scientific organization in the state, that scientific publications were few and difficult to obtain, and that there was no uniform method for publication of scientific papers. As a result, he tried to organize a scientific association in Topeka, but met with little response. Later in the same year, Parker wrote to Prof. B. F. Mudge, at the State Agricultural College at Manhattan, trying to enlist that scientist's help in forming a scientific association. After visiting Mudge during the summer months of 1867, Mudge, who had been in sympathy with the movement from the very first, agreed to endorse Parker's plan to organize a state scientific association. A call, printed in the "Journal of Education" for March, 1868, and signed by seventeen persons resulted in the formation of the Kansas Natural History Society on September 1, 1868, in the College building of Lincoln College, Topeka. This meeting, due to unfavorable weather, was attended by but a few men. Mudge, the only person not from Topeka, was elected as the society's first president and Parker as its first secretary. No scientific papers were read at this meeting. At the second annual meeting held at Topeka in 1869 only three papers were read. Gloom prevailed and the

Trans. Kansas Acad. Science, Vol. 41, 1938.

JOHN DEMPSTER PARKER
First Secretary



B. F. MUDGE
First President

FOUNDERS OF THE KANSAS ACADEMY OF SCIENCE

future of the newly organized society looked dark indeed. The turning point of the society came the next year, 1870, when the annual meeting was held at the University of Kansas at Lawrence. At this meeting eight papers were read. Resolutions were presented to enlarge the scope of the society to include every line of scientific exploration and investigation and to change the name of the society to the Kansas Academy of Science. Both resolutions were adopted at the fourth annual meeting held at Leavenworth in the following year.

The next important event in the history of the Academy happened in 1873 when the state legislature made the Academy a coördinate department of the State Board of Agriculture. By the same act, the Academy was assured publication of its proceedings by providing that they be published as appendices to the reports of the State Board of Agriculture. Rooms in the statehouse were also furnished the Academy. This act by the state legislature and the general recognition of the scientific efforts of the Academy, coming without solicitation, naturally engendered a high spirit of optimism among the few men of science. The future of the Academy now appeared brighter. Interest in science in Kansas began to grow, as is evidenced by the increase in the number of papers read at the annual meetings and later published, and by the addition of new members. The history of the Academy from this time on is perhaps normal to that of most organizations with its peaks of rapid growth and high enthusiasm and its corresponding depths of despair. Beginning in 1895 and continuing to 1921 the Academy experienced a boom financially. This was the period of generous state aid, with an appropriation of $800 in 1895, a maximum of $1,663.21 in 1902 and $1,300 from 1905 to 1919. The bottom dropped out, however, in 1921, and for the next twelve years the Academy received no financial help from the state legislature. In 1933 an annual state appropriation of $300 was again provided, one that is in effect at the present time.

Another important event in the Academy's history took place in 1908, when the Academy secured the annual publication of its TRANSACTIONS. Previous to this time the TRANSACTIONS appeared biennially. This joy of having a yearly publication came to grief in 1919 and continued to 1928, during which time the Academy published but two volumes of the TRANSACTIONS. Volume 30, for the years 1919 to 1921, appeared in 1921, and volume 31, for the years 1922 to 1928, was published in 1928. Other important events that may be mentioned are: the end of the Academy's economic museum in 1916; the affiliation of the Academy with the A. A. A. S. in 1919; the beginning of the conservation committee in 1921; the $500 income from the University of Kansas for the exclusive exchange rights of the TRANSACTIONS in 1929; the division of the Academy library in 1930 between the University of Kansas, Kansas State College at Manhattan and the Fort Hays Kansas State College, with an agreement to pay the Academy the sum of $500 annually for a period of ten years; the appointment of the following committees: Junior Academy, Endowments and Investments, Coördination of Scientific Groups, and the reviving of the Conservation Committee, the establishment of an editor separate from the secretary in 1931, and the selection of a managing editor in 1934; the establishment of an editorial board in 1935 and the adoption in 1937 of the policy to elect the Academy president a year before taking office.

MAJOR PROJECTS OF THE EARLY ACADEMY

The Kansas Academy of Science was founded for the purpose of "securing the advantages arising from association in scientific pursuits and of giving a more systematic direction to scientific research in our state" (3). The Academy from the very beginning busied itself with several major projects. It was not content to come together once a year solely for the purposes of reading scientific papers and making new friends.

The Geological Survey Project. The first one of the major projects undertaken by the Academy was the promotion of a geological survey for the state of Kansas. Previous to the organization of the Kansas Natural History Society, or our Academy in 1868, Mudge had been appointed as the first state geologist of Kansas. This honor was conferred upon him by the state legislature on February 15, 1864, after he had delivered a course of geologic lectures before that body. Mudge served one year. In the following year, Prof. G. C. Swallow became state geologist. He, like Mudge, served but one year. With Swallow, the Kansas geological survey went out of existence. Mudge, in the meantime, was appointed geologist for the State Board of Agriculture, a position he held until the time of his death twelve years later. The need for a geological survey, and the desire to have one, did not die with the demise of the first two geological surveys. Mudge was preëminently a geologist. The first paper ever given before the Academy was read by him and was entitled "On the Internal Heat of the Globe" (4). During his association with the Academy, Mudge, who served the entire time either as its president or vice-president, read twenty-four papers on some phase of geology. At the seventh annual meeting held at Topeka on October 5 and 6, 1874, Professor Mudge read a paper entitled "A Geological Survey of Kansas" (5). In this paper special attention was directed to the needs and economic importance of a geological survey. In 1875 the Academy passed a resolution to this effect, and in the following year adopted it. The persistence and determination to establish a geological survey is well indicated in the closing paragraph of Dr. A. H. Thompson's retiring presidential address given at the sixteenth annual meeting, on November 21, 1883, when he said:

"In the furtherance of our work one thing remains for us to accomplish before our honor and dignity shall be complete, and that is the geological and scientific survey of the state. That is one main object of our existence, and toward its accomplishment we must labor continuously until success shall crown our efforts, as it is certain to do. We must agitate the subject in season and out of season, until we obtain final victory. It is a duty we owe to ourselves, to the state, and to science." (6).

In the following year Dr. R. J. Brown read as his presidential address, "Is a Geological Survey of the State a Necessity?" The addresses of these two retiring presidents resulted in the appointment of a committee on securing a state geological survey. At the eighteenth annual meeting, held at Manhattan in November of 1885, this committee reported as follows:

"Your committee begs to report that strenuous efforts were made to secure the passage of a bill providing for a geological survey of the state, by the last legislature; but their efforts were unsuccessful, although there was much interest manifested in the subject. We would recommend that the effort be continued at the next extra session. There is a popular demand for the work, as well as an economic necessity. Detailed report, copies of bills, circulars, etc., have been deposited with the secretary." (7)

Again in 1888, Prof. Robert Hay, in his lecture given before the Academy on "The Geology of Kansas," pleaded for a geological survey when he said:

"In conclusion, we may express the desire that this audience will use means to influence legislators to cause a survey to be made of this state, which will aid in developing our resources, and help to bring scientific problems to a correct solution." (8)

Finally, in 1895, the state legislature reëstablished the Kansas Geological Survey and thus made real the most cherished dream of the Academy. Before this was done, however, at least 110 geological papers were published in the TRANSACTIONS of the Academy.

The Museum Project. A second major project or ambition of the early Academy was the establishment of a scientific museum. It was an early thought of the founders of the Academy that large scientific collections would be made by the members and that these would be secured to the state. At the organization meeting one of the officers elected was a curator, whose duty was to be in charge of the collections. Material began to accumulate, but it was not until the Academy became a coördinate department of the Board of Agriculture and was provided with rooms, that anything like a display was made. By legislative act, the Academy was instructed to place and keep for public inspection geological, botanical and other specimens. Mudge, who was a great collector, was especially concerned with the preservation for Kansas of the rare specimens, many of which were finding their way out of the state. He was constantly receiving specimens from all parts of the state, and during the summer months made extensive collecting trips. His collections were considered to be the richest and best in the entire West. In coöperation with the Board of Agriculture many specimens were secured to form the basis of a fair natural history collection. The specimens of this collection were labeled and arranged by members of the Academy and constituted a source of great interest to the many visitors to the statehouse, where the collection was housed. Apparently, however, specimens were received in greater numbers than could be taken care of, with the result that many of them were stored in boxes and stacked in various corners and dark rooms. President D. E. Lantz (9) in his presidential address, delivered on December 30, 1898, lamented on the general condition of the Academy collection and stated that the mineralogical exhibit in the basement corridor of the south wing of the capitol building was a dilapidated mineralogical ruin. He called attention to the educational value of the collection and pleaded for display cases, suitable exhibit rooms, and a paid curator, and expressed the opinion that—

"No better means can ever be planned for advertising the resources of the state and inducing immigration and the investment of capital than that afforded by a great exhibit of our economic geology." (10)

In 1900 the Academy's Committtee on Welfare of the Academy urged the establishment of an economic museum of the industrial products of the state for popular instruction and recommended further the discontinuance of collecting specimens of nonindustrial value. This same committee asked the legislature for $500 to be used for the purchase of new museum cases for the Goss collection of birds and for the industrial collection. Although not recorded by the secretary of the Academy, the state legislature must have granted the $500 requested, for in 1903 the secretary reported the purchase of

eight new showcases for the museum and that the museum of mineral industries had been arranged and much valuable material had been added. The secretary of the Academy had also been given charge of the collecting and arranging of the Kansas mineral displays to be exhibited at the St. Louis World's Fair. This exhibit, which received two gold, twenty-two silver, and fourteen bronze medals, and valued at $8,000 with cases, became the property of the Academy after the close of the fair. For a number of years the museum was the pride of the Academy. The continued demand for more room by the various growing state departments finally made it necessary for the Academy to move to new quarters in Memorial Hall. This move practically meant the end of the museum, for, as reported, the work of boxing and moving the museum was done by incompetent persons, with such serious damage that it was doubtful whether the collections could ever be put into usable condition again (11). In spite of the serious damage to the collections, efforts were again made to build up the industrial museum. Hundreds of letters were written requesting material for the museum. The response was slight and so discouraging that further attempts to secure specimens were soon abandoned. In the process of moving, labels were lost, dissarranged and soiled so that the collections were made practically worthless. The end of the industrial museum, the one-time pride of the Academy, followed when on cleaning the building the museum made such an unsightly showing that the secretary, with the permission of several Academy members, sent the specimens of minerals to the University of Kansas to be used there in the ore-dressing department. Later, the exhibit cases were loaned to the University, where in subsequent years they were scattered among the various departments. Thus was the end of the museum project.

The Library Project. When the Academy was organized scientific reports, publications and scientific libraries, especially in the West, were not very common. The need for a scientific library was keenly felt by the founders of the Academy, and it is but natural that the building up of a library became from the very beginning a major project. Books, reports and pamphlets were secured through exchanges with the TRANSACTIONS, direct purchases and through gifts. The building up of a library was not without its difficulties. As the library grew, problems of housing, indexing, cataloguing and binding arose. Considerable friction later developed between the Academy librarian and the secretary of the State Historical Society, which also was developing a library of its own. The Academy felt strongly that there was too much duplication and even triplication of publications, and hence needless spending of state money among the various state departments, all of whom were trying to have libraries of their own. The Academy hoped that plans would be formulated for the consolidation of all the libraries in the statehouse under a common head and that it would be in charge of the scientific portion of that library. The library situation was not helped by a state law which favored the State Historical Society to the extent that it was entitled to receive yearly from the Academy sixty bound volumes of the TRANSACTIONS, as well as other books published by the state. These volumes were used by the State Historical Society for exchanges for the publications of foreign scientific societies which already were on the exchange list of the Academy and which thus created another source of duplication of books. According to the secretary's report

(12) the State Historical Society had cords of such duplicated publications stored in their closets and dark rooms, books which were doing good to no one. In 1916 the secretary reported the removal of the Academy library to its new quarters in Memorial Hall, where it had been expected that the library would be shelved and catalogued by the Historical Society, but that nothing had been accomplished up to that time. In 1917 the Academy had 4,000 volumes shelved, labeled and classified, but not catalogued, and hence useless for reference purposes. Agreement made with the State Historical Society for the cataloguing of the Academy's books was not carried out. The Historical Society did place, however, many of the Academy's books and periodicals with its library in order to complete broken files, the secretary of the Academy having a list of these books. As the library situation did not improve, the Academy library was by legislative enactment located at the University of Kansas (13), at which place it remained until 1930. In 1930 the library was divided among the University of Kansas, Kansas State College at Manhattan and the Fort Hays Kansas State College. Due to the suspension of the publication of the TRANSACTIONS because of no state printing, the foreign exchange list rapidly decreased. The Academy instructed its committee on publication to place the Academy's library in one of the state institutions which would properly house it and would pay some money to the Academy for the exchanges received through the TRANSACTIONS, and which would help finance the publication of the TRANSACTIONS (14). In 1928 the Academy, realizing the importance of publishing its TRANSACTIONS in order to maintain its exchanges with foreign scientific societies, voted to publish the TRANSACTIONS out of Academy funds and also to apply all funds not absolutely needed for actual expenses toward its publication. A publication committee consisting of five was organized, one of whose members was to be designated editor. The Academy also voted to eliminate exchange publications unless exchanges could be made to work to the immediate financial advantage of the Academy. This action was forwarded to Chancellor Lindley, of the University of Kansas, where the Academy library at that time was housed, and to President Farrell, of the Kansas State College at Manhattan, on June 7, 1928. The suggestion at that time was made to purchase copies of the TRANSACTIONS for the purpose of library exchanges with other academies and societies. No action was taken by the Kansas State College. The University, however, agreed to pay the Academy not more than three dollars per page per volume up to a maximum of $500 per year, for which it was to receive the exclusive rights of exchange for the publication of the Kansas Academy of Science. This agreement was accepted by the Academy and was made for two years with the privilege of renewing it. At the sixty-second annual meeting, held on April 17 to 19, 1930, at Fort Hays Kansas State College, the publication committee presented an elaborate report concerning the disposition of the Academy library. This report was accepted and its recommendations approved. The report was then submitted to the University of Kansas, Kansas State College at Manhattan and the Fort Hays Kansas State College for consideration. All three institutions accepted section B (15) of the publication committee's report, according to which the first two institutions were to pay the Academy each $200 annually and the Fort Hays Kansas State College $100 per year, for a period of ten years. In return, the Academy agreed to

divide its library among the three institutions in proportion to the amount paid to the Academy, the exact division to be made by the librarians of the three institutions. The agreement also provided that the Academy furnish each institution one copy of the TRANSACTIONS per year for each dollar it received during the ten-year period. By agreement also the Academy gave permanent possession of the portion of the Academy library received by each institution, with exclusive exchange rights, which were to be decided by the institutions involved in an equitable manner agreeable to all three concerned. In 1937 (16) the exchange list of the three institutions through the TRANSACTIONS totaled at least 325, of which 152 were foreign and 173 domestic. According to Doctor Baumgartner's report (17) the Academy has accumulated about 20,000 (roughly estimated) volumes of scientific reports, books and pamphlets, all of which "by a system of mutual loaning are available to every one of the Academy members from any one of the three coöperating institutional libraries." This, then, constitutes the status of the Academy library until 1940, when the agreement with the three institutions and the Academy expires.

OTHER INTERESTS

Besides the three major projects just described, the Academy has been interested in many other worth-while enterprises, as is indicated by the appointment of various committees, some of which are given below.

1896. Committee appointed to prepare and publish scientific monographs on the natural resources of Kansas—monograph on geology selected as the first one.

1897. Committee appointed to study the matter of science teaching in our public schools.

1902. Committee appointed to investigate the presence or absence of gold in the shales of Western Kansas.

1910. Committee appointed to seek assistance of the Kansas Board of Health in trying to procure legislation to prevent the use of mineral poisons in embalming fluids.

1912. The Academy moved to go on record as favoring a national law for the protection of bird life in the United States.

1917. Committee appointed to make an oil and gas survey of Kansas. A second committee was appointed to arrange for a course of popular scientific lectures at Topeka. (Eight lectures were given.)

1921. The Academy became interested in conservation. A plea was made to preserve places of beauty.

1925. Members of the Academy prepared a general account of ecological features of Kansas and published it in the Naturalists Guide.

FINANCIAL HISTORY

No active organization is without a financial history. The income of the Academy is obtained from (1) annual dues, (2) grants from three educational institutions, (3) appropriations from the state legislature, (4) research grant from the A.A.A.S., and (5) interest on the Academy's endowment. The annual dues of our Academy throughout most of its history has been one dollar. This amount was stipulated in the original constitution. For a number of years, at least from 1883 to 1890, the dues were two dollars. In 1890 this amount was again reduced to one dollar. Attempts to increase the annual dues as well as to charge an initiation or entrance fee met with failure. (18) The annual dues of the Kansas Academy of Science are among the lowest paid by any academy, as may be seen from the following table.

TABLE 1.—Annual dues of Academies of Science

Number and name	Annual dues
15 (Kansas and 14 others)	$1.00
1 (Missouri)	1.50
7 (Wisconsin, Georgia, Tennessee, Virginia, Colorado, Wyoming, Pennsylvania, Florida)	2.00
1 (Ohio)	2.50
1 (St. Louis)	3.00
1 (Maryland)	5.00
1 (New York)	3.00 to 10.00

With the exception of 1921 to 1933, the Academy received yearly appropriations from the state legislature since 1895. The total amount thus far received amounts to $33,160 (Table 2). The state legislature was very generous in the early days of the Academy. The first appropriation was $800. This amount was gradually increased until in 1902 the Academy received from the state a little over $1,600. From 1904 to 1919 the annual income from this source was $1,300. Beginning in 1921 and continuing to 1933, the state legislature failed to remember the Academy. For the last four years we are again receiving state aid to the extent of $300 annually. It is our hope that this amount may be increased to at least $500 per year in the very near future. The Academy is very grateful for the money received through the state appropriations, for without it, especially in the early days, its work would have been very much retarded.

In the early days of the Academy, when more or less permanent headquarters were maintained in the statehouse, a great effort was made to build up a large scientific library. As a result of exchanges, purchases and gifts the Academy accumulated a large number of volumes of scientific books, reports, and

TABLE 2.—State Legislative appropriations to the Academy

Year	Amount	Year	Amount
1895-'96	$800.00	1919-'20	1,000.00
1896-'97	800.00	1920-'21	1,000.00
1897-'98	900.00	1921-'22	....
1898-'99	900.00	1922-'23	....
1899-1900	1,220.00	1923-'24	....
1900-'01	1,120.00	1924-'25	....
1901-'02	1,270.00	1925-'26	....
1902-'03	1,663.21	1926-'27	....
1903-'04	1,187.47	1927-'28	....
1904-'05	1,300.00	1928-'29	....
1905-'06	1,300.00	1929-'30	....
1906-'07	1,300.00	1930-'31	....
1908-'09	1,300.00	1931-'32	....
1909-'10	1,300.00	1932-'33	....
1910-'11	1,300.00	1933-'34	300.00
1911-'12	1,300.00	1934-'35	300.00
1912-'13	1,300.00	1935-'36	300.00
1913-'14	1,300.00	1936-'37	300.00
1914-'15	1,300.00	1937-'38	300.00
1915-'16	1,300.00	1938-'39	300.00
1916-'17	1,300.00		
1917-'18	1,300.00		$33,160.00
1918-'19	1,300.00		

pamphlets. When the Academy lost its permanent home in the state capitol building, the library became a burden on its hands. In 1929 the University of Kansas purchased the exclusive exchange rights of the Academy's TRANSACTIONS for $500 and thus solved, for the time at least, the library problem, besides giving the Academy a very much welcomed income. The following year the library was divided between the University, Kansas State College at Manhattan, and Fort Hays Kansas State College. In return, the Academy received from these three institutions a total of $500 a year with the understanding that this amount would be paid for ten years, or until 1940. This source of revenue is a great aid in helping the Academy to function efficiently.

In 1920 the Academy affiliated with the A. A. A. S. By this affiliation the Academy was reimbursed by the A. A. A. S. one dollar for every one of its members belonging to both organizations. This amount was reduced to fifty cents in 1926. Still later the A. A. A. S designated that the allotted money ($75) should be used solely for research grants. In addition to the income thus far indicated, the Academy also receives some money as interest on its endowment, which at the present time has accumulated to approximately $4,000.

THE TRANSACTIONS

To the outside world the Academy is best represented by its official publication, the TRANSACTIONS. Up to the present time, the Academy has issued 40 volumes, containing 9,299 pages (fig. 3). Volume 41, for the year 1938, is now in press. All of these volumes, with the exception of volumes 31 to 36, inclusive, and which contain papers and reports of officers and other business matters for the years 1921 to 1933, have been printed by the state printer without any cost to the Academy. Due to an oversight in the process of codifying the laws of Kansas, the printing of the TRANSACTIONS by the state printer was overlooked. As a result, volumes 31 to 36 were printed by the Academy out of private funds.

Although organized in 1868, the Academy was without publication until it was made a coördinate department of the State Board of Agriculture in 1873 by legislative act. This act provided that:

"An annual report of the transactions of said Academy of Science shall be made on or before the fifteenth day of November, of each year, to the State Board of Agriculture, for publication in the Annual Transactions of said Board" (19).

Volumes I, II, and III were published as parts of the state agricultural reports for 1872 to 1874. In 1896 these three Academy reports were combined and reprinted by the Academy as the first separate bound TRANSACTIONS. From that time on until the nineteenth volume was issued, the TRANSACTIONS appeared biennially. A marked step forward for the Academy was taken when, beginning with the twentieth volume, the TRANSACTIONS appeared annually except as indicated below.

Papers and reports for annual meetings

Volume	Published	Contents
23 and 24	1911	42 and 43
28	1918	48 and 49
30	1922	51 to 53
31	1928	54 to 60

In addition to the volumes of the TRANSACTIONS, the Academy has published three bulletins and one special pamphlet. The latter, "National Monument Project of the Kansas Academy of Science," is a sixteen-page pamphlet describing the geology, flora and fauna of an area of concretions near Minneapolis, Kan., which the Academy is sponsoring as a national monument. This pamphlet was published by the state printer in 1937, and 10,000 copies of it were distributed. The bulletins referred to above contain presidential addresses and reports of annual meetings.

The TRANSACTIONS contain the official business records of the Academy and scientific papers read at its annual meetings. Including this year (1938) 2,134 papers representing practically all branches or fields in science were read before the Academy. Of these 1,207 are published in the various volumes of the TRANSACTIONS. The volumes of the TRANSACTIONS have been and are being used for purposes of exchange. It was largely by this means that the Academy was able to build up a large and important scientific library previously discussed and which in more recent years has been a source of considerable revenue to the Academy. The scientific development and interest of the Academy, as attested by the number of pages published and by the number of papers presented, is graphically shown by figures 3 and 4.

MEMBERSHIP

On March 10, 1938, the Academy had a total membership of 727. On March 31, 1937, the membership was 541, a year earlier 430, and on May 25, 1935, it was 344. From these figures it is seen that the Academy is making a substantial growth each year. The total membership, although impressive, is not as significant in showing the real growth of the Academy as is the annual increase in new members, as may be seen from figure 5. This graph gives data for the years 1887 to April 2, 1938. It will be noted that in recent years the growth of the Academy has been unusually rapid. During the past year ending April 2, 1938, the Academy has voted in a total of 180 new members.

RELATIONSHP TO OTHER ACADEMIES OF SCIENCE

Very little need to be said concerning the Academy of today. The Academy today, like in the past, is interested in more than the holding of an annual meeting at which scientific papers are read and discussed and at which new acquaintances are made and old ones renewed. In addition to the attempts to increase the financial resources of the Academy for purposes of research, publication of natural history handbooks, etc., and a study of the educational trends in our secondary schools, special emphasis is being concentrated in promoting the Junior Academy of Science, in coördinating all scientific groups in the state into a Kansas Association for the Advancement of Science, in forming a section for the improvement of high-school science teaching and in the establishment of a national monument near Minneapolis, Kan. That progress is being made along all of the lines just enumerated will be apparent to you later when the committee reports are made.

I have traced for you the organization, growth, development and history of our Academy. I am certain that you will agree with me that the Kansas Academy of Science has a splendid record. In this connection it may be of interest to know how we, as an academy, compare with other academies of

science in the United States. Shortly after having been chosen president-elect, I prepared a questionnaire and sent it to twenty-nine academies affiliated with the A. A. A. S., and to one nonaffiliated academy. The purpose of this questionnaire was to get ideas concerning organization and activities of academies in order to plan better the work of our own Academy for the coming year and incidentally to learn how the Kansas Academy compared with other similar organizations. I received twenty-seven replies from the thirty academies to whom the questionnaire was sent. The following is a summary of the data compiled from the replies received. The Kansas Academy is the fifth oldest academy and perhaps the first state academy to have been organized (table 3). The Maryland Academy of Science was founded in 1797; however, like the New York, New Orleans and the St. Louis academies, it is essentially a local (Baltimore) organization. In membership our Academy ranks ninth, in attendance at the annual meetings, sixth; in the number of high-school science clubs affiliated with the Junior Academy, seventh; in the amount of endowment, fifth; and in the income other than from dues and endowment, fifth. In addition, the annual dues of the Academy are among the lowest paid in any similar organization and we are one of the five academies favored by having our proceedings and scientific papers published by the state. From this summary, it is clear that our Academy ranks very well in all respects when compared with other academies. Detailed data is given in tables 1 and 3 to 9. My survey also shows that twenty-one of the academies have their annual meeting in early spring, New York has twenty-eight meetings during the year, St. Louis fifteen, New Orleans five, and Indiana, Oklahoma, Tennessee, Minnesota and Florida have each two meetings. Twelve academies have field trips in connection with their annual meetings, and four occasionally. Michigan, South Carolina, Louisiana, Florida, Virginia and New York offer prizes for noteworthy research or outstanding scientific papers. Our Academy is well represented by scientific sections, but as may be seen from Table 10, might well organize at least a section for medicine and one for mathematics.

TABLE 3.—Organization of academies

Maryland	1797	Kentucky	1914
New York	1817	New Hampshire	1919
New Orleans	1853	Georgia	1922
St. Louis	1856	Virginia	1923
KANSAS	*1868*	Northwest	1923
Wisconsin	1870	South Carolina	1924
Indiana	1885	West Virginia	1924
Iowa	1886	Pennsylvania	1924
Ohio	1891	Louisiana	1927
Nebraska	1891	Colorado—Wyoming	1927
Michigan	1894	Minnesota	*1932
Illinois	1908	Missouri	1934
Oklahoma	1909	Florida	1936
Tennessee	1912		

* Reorganized.

TABLE 4.—Academy memberships in 1937

Michigan	1,000	Oklahoma	410
Illinois	927	St. Louis	404
Indiana	900	Wisconsin	350
Iowa	800	South Carolina	300
Missouri	800	Florida	280
Virginia	737	Kentucky	263
New York	630	West Virginia	260
Minnesota	550	Colorado—Wyoming	250
KANSAS	*541*	New Orleans	220
Ohio	510	Nebraska	150
Northwest	500	Louisiana	150
Maryland	450	New Hampshire	140
Tennessee	425	Georgia	105
Pennsylvania	425		

TABLE 5.—Attendance at annual meetings

Illinois	800	South Carolina	225
New Orleans	500	Wisconsin, Louisiana	200
Missouri	500	Kentucky, Pennsylvania	175
Michigan	450	Florida	150
Virginia	417	Georgia	100
KANSAS, Iowa, West Virginia	*350*	New Hampshire	100
Oklahoma, Northwest	300	Tennessee	80
Ohio, Nebraska, Minnesota	250		

TABLE 6.—Endowments in 1937

New York	$100,000.00	Iowa	$2,000.00
St. Louis	17,500.00	Ohio	1,700.00
Virginia	10,000.00	Northwest	1,095.00
Louisiana	5,000.00	Kentucky	856.00
KANSAS	*2,820.40*		

TABLE 7.—Income other than from dues and endowment in 1937

Tennessee (for biological station)	$2,500.00
Indiana (state legislature)	1,500.00
Maryland (city of Baltimore)	1,500.00
Illinois (state general assembly)	1,000.00
KANSAS (state legislature, three state institutions, authors, etc.)	*835.00*
New York (sales of publications)	500.00
Florida (institutional sustaining members)	350.00
Northwest	100.00
Virginia (interest)	14.48

Ohio receives a small amount from Ohio State University.

TABLE 8.—Junior Academy for 1937

	Clubs		*Clubs*
Illinois	50	St. Louis	8
W. Virginia	30	KANSAS	6
Pennsylvania	29	Louisiana	4
Iowa	22	Minnesota	4
Kentucky	21		

Indiana and Nebraska have Junior Academies, but did not report the number of affiliated clubs. There is a junior academy in Oklahoma, but is not reported as being part of the Oklahoma Academy of Science.

TABLE 9.—Status of Academy Publications

Printed by	Number	Academies
State	5	KANSAS, Iowa, West Virginia, Illinois.*
State University	1	Michigan.
State University and Academy	1	Georgia.
Private	19	Illinois and 18 others listed in Table 2.

* Illinois publishes quarterly. Half of the publications are printed by the state, the others by the Academy.

TABLE 10.—Scientific sections not represented in the Kansas Academy

Agriculture	2	Illinois, Missouri.
Anthropology	4	Illinois, Michigan, Missouri, New York.
Archaeology	1	Indiana.
Bacteriology	1	Indiana.
Biochemistry	1	Nebraska
Engineering	2	Missouri, Northwest.
Forestry	2	Michigan, Northwest.
Geography	4	Illinois, Michigan, Nebraska, Northwest.
Geophysics	1	Missouri.
Mathematics	6	Indiana, Michigan, Missouri, Nebraska, Pennsylvania, Virginia.
Medicine	10	Georgia, Louisiana, Michigan, Missouri, New Orleans, Northwest, Ohio, Pennsylvania, Virginia, West Virginia.
Soil Conservation	1	Northwest.

FUTURE OF THE ACADEMY

One cannot, of course, prophesy what the future has in store for the Academy. Nevertheless, there are certain indications or signs that tend to forecast for us a much greater Academy in the near future. One of these signs, I believe, is the increasing number of new members added yearly. Previous to 1929 an increase of fifty new members per year was unusual. Since 1935, however, the Academy has added each year over 100 new members as follows: 104 in 1935, 118 in 1936 and 180 in 1937. This remarkable growth in new members is perhaps best explained first by an increased effort on the part of our present members to get new members, and second on the desire of nonmembers to affiliate with the Academy because of their appreciation of its position and importance in the development of science in Kansas. With a better organized membership committee and its newly appointed institutional representatives, together with more definitely planned projects, there is every reason to believe that even more members will join the Academy in the next few years than have ever done so before.

The increase in the number of papers read before the Academy in recent years also indicates a growing interest in science and in the Academy. Since 1929, the number of papers read at the annual meetings was never less than 100, except in 1930. Previous to 1929 the maximum number of papers presented at any annual meeting was 73, with an average of less than 50. The increased interest in scientific research is nationwide. Better publications, more funds available for research grants and larger scientific sections at our annual meetings are additional factors to the nationwide research interest which undoubtedly have contributed to the increased activity in our own

Academy. Effort to increase our research fund, constant improvement in the format of our TRANSACTIONS, less delayed publications, should all help to increase still more a desire to prepare, read and publish papers in the near future.

Not least among the factors contributing to a greater Academy in the years to come is the policy, adopted in 1937, of electing its president a year before taking office. This step made it possible for the first time for the president-elect to plan the affairs of the Academy well in advance, to select his committees in time for each one to meet as a committee at the annual meeting, to outline the duties of each committee and to set forth certain definite goals or objectives for each committee to reach during the year of his administration. The committees, with their objectives, were given to you at one of the earlier sessions of this meeting. I am sure that with the hearty coöperation of all members in trying to attain the goals set forth for each committee, the Kansas Academy of Science will not only continue to grow as in the past, but will at the close of the coming year be able to present an achievement record which will place our Academy as the foremost scientific academy in the United States.

LITERATURE CITED

1. THOMPSON, A. H. The Origin and History of the Academy. Trans. Kansas Acad. Sci., 9:4-16. 1884.

LANTZ, D. E. The Kansas Academy of Science. Trans. Kan. Acad. Sci., 16:24-33. 1898.

WOOSTER, L. C. The Development of the Sciences in Kansas. Trans. Kan. Acad. Sci., 20, Part I:23-40. 1905.

HARSHBARGER, W. A. Address of the Retiring President. Trans. Kan. Acad. Sci., 27:30-40. 1915.

WILSON, WM. B. The Kansas Academy of Science, Its Position and Mission. Trans. Kan. Acad. Sci., 33:146-153. 1930.

2. PARKER, J. D. Letter to Dr. A. H. Thompson. Trans. Kan. Acad. Sci., 9:9-10. 1885.

——— Organization and History. Trans. Kan. Acad. Sci., 1:3-7. 1872. Reprint, 1896.

——— Letter to Prof. B. B. Smyth. Trans. Kan. Acad. Sci., 17:8-9. 1901.

HARSHBARGER, W. A. Symposium: Fifty Years of Scientific Development in Kansas. The Kansas Academy of Science. Trans. Kan. Acad. Sci., 29:35-41. 1918.

WOOSTER, L. C. Botany in Kansas During the Past Fifty Years. Trans. Kan. Acad. Sci., 29:41-43. 1918.

BAILEY, E. H. S. The Progress of Chemistry in Kansas During the Last Fifty Years. Trans. Kan. Acad. of Sci., 29:44-46. 1918.

WILLISTON, S. W. The Progress of Science Since the Foundation of the Kansas Academy of Science. Trans. Kan. Acad. Sci., 29:53-61. 1918.

WOOSTER, L. C. Field Work vs. Laboratory Work. Trans. Kan. Acad. Sci., 34:33-37. 1931.

BAUMGARTNER, W. J. The Kansas Academy of Science. Science, 85:335-336. 1937.

WOOSTER, L. C. Some of the Founders and Workers of the Kansas Natural History Society and the Kansas Academy of Science. Trans. Kan. Acad. Sci., 40:215-220. 1938.

3. PARKER, J. D. Organization and History. Trans. Kan. Acad. Sci., 1:4-5. 1872. Reprint, 1896.
4. HARSHBARGER, W. A. Address of the Retiring President. Trans. Kan. Acad. Sci., 27:34. 1915.
5. MUDGE, B. F. A Geological Survey of Kansas. Trans. Kan. Acad. Sci., 3:101-102. 1874. Reprint, 1896.
6. THOMPSON, A. H. The Origin and History of the Academy. Trans. Kan. Acad. Sci., 9:16. 1884.
7. Committee report. Trans. Kan. Acad. Sci., 10:3. 1887.
8. HAY, R. The Geology of Kansas. Trans. Kan. Acad. Sci., 11:37. 1889.
9. LANTZ, D. E. The Kansas Academy of Science. Trans. Kan. Acad. Sci., 16:24-33. 1898.
10. *Ibid.*, p. 28.
11. Minutes of the 48th Annual Meeting, January 14, 1916. Trans. Kan. Acad. Sci., 28:16. 1918.
12. Secretary's Report, Ottawa Meeting, 1909. Trans. Kan. Acad. Sci., 23 and 24:14. 1911.
13. Letter from Chancellor Lindley Regarding Academy Library. Trans. Kan. Acad. Sci., 31:20. 1928.
14. Minutes of the 59th Annual Meeting. Trans. Kan. Acad. Sci., 31:41. 1928.
15. Report of the Publication Committee. Trans. Kan. Acad. Sci., 33:20-22. 1930.
16. Kansas Academy of Science Exchanges. Trans. Kan. Acad. Sci., 40:411-422. 1938.
17. BAUMGARTNER, W. J. The Kansas Academy of Science. Science, 85:335. 1937.
18. JOHNSON, G. E. A Study of Financing Academies of Science. Trans. Kan. Acad. Sci., 35:34-37. 1932.
19. THOMPSON, A. H. The Origin and History of the Academy. Trans. Kan. Acad. Sci., 9:13-14. 1885.

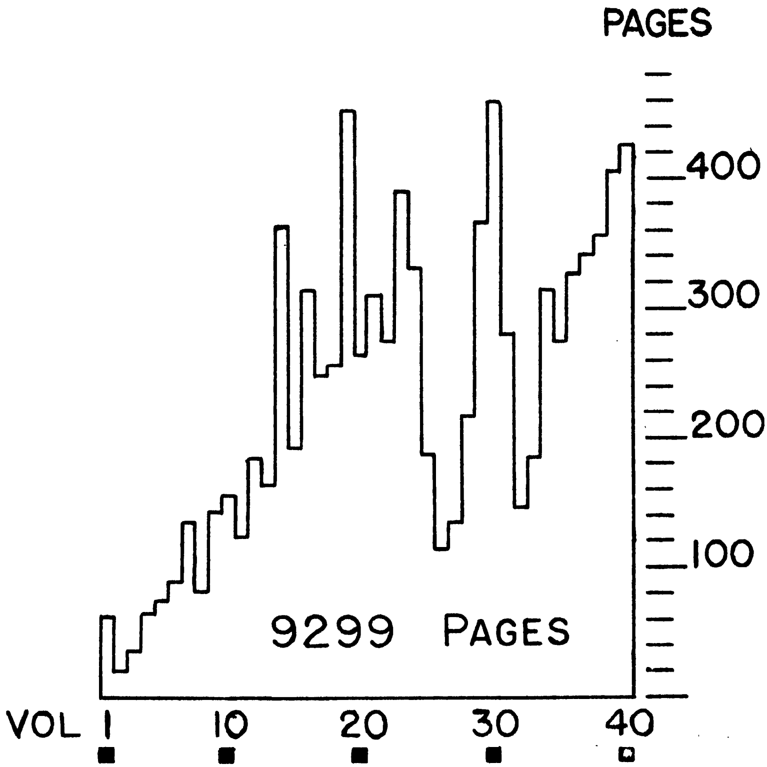


FIG. 3. Graph showing the number of pages for volumes 1 to 40 of the TRANSACTIONS

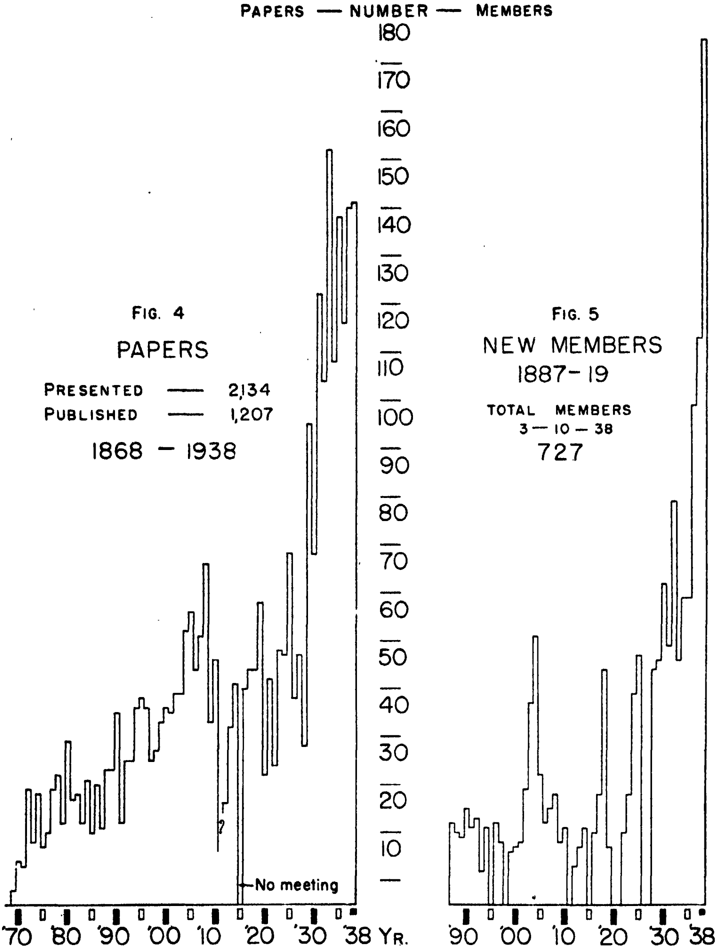


Fig. 4. Graph showing the number of papers read at the annual meeting from 1868 to 1938.

Fig. 5. Graph showing the annual increase in new members from 1887 to 1938.

PRINTED BY KANSAS STATE PRINTING PLANT
W. C. AUSTIN, STATE PRINTER
TOPEKA 1938
17-4992